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NOTICE.

Further discussions of articles in the present number are requested. They will be published in the next number of the Proceedings.

THE PROCEEDINGS

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UNITED STATES NAVAL INSTITUTE.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

HONORABLY MENTIONED.

MOTTO :—" However small thy world may be,
Do thou but lead it right ;
Thy work for good let all men see,
Although that work be slight."

—[From Schiller as translated by Major E. Gunter, S. E. D., from the *Militar Wochenblatt.*]

SUBJECT: "NAVAL APPRENTICES, INDUCEMENTS, ENLISTING, AND TRAINING. THE SEAMAN BRANCH OF THE NAVY."

By ENSIGN RYLAND D. TISDALE, U. S. Navy.

INTRODUCTORY.

During the last few years, several valuable essays have been written by our naval officers on the subjects of "Naval Training," "Naval Training and Discipline," "Enlistment and Training of Seamen," "The Training Service," etc., and the discussions thereon have been quite full and varied. It, however, appears that the subject of this article has been left pretty much where it stood. The main points of these essays seem to be whether our cruisers shall have full sail power, whether the

marines should remain on board ship, remarks on the types of ships built, or stating officers' and seamen's grievances. There are a great many good points in each one of these essays, as well as the discussions, but no very great attention is paid to the apprentice in particular.

It is the opinion of the writer, and, I believe, that of many officers, especially those who have recently served on training ships, that the present system of dealing with apprentices, and their disposal after leaving training ships, should be greatly modified or abandoned.

The apprentices are often considered of no particular value on board the general service ship, and a good many of the commanding officers consider them a nuisance and bother. They seem to be used principally for messengers and signal boys.

After leaving the training ship it appears that, in a practical sense, the apprentices receive but little special instruction or care, and that they are given, at first, too many privileges of men. The regulations, it is true, require instruction, and an examination every quarter. The examinations are often mere forms, as evidenced recently by one officer having, in a day, examined forty apprentices on a new cruiser. No officer on the training ship can examine one-half that number in one branch alone (seamanship or gunnery) in this time.

Apprentices transferred to a ship just going into commission, or during the first part of a cruise, are lucky, for they, with the men, will be taught their various duties, as every one is making an endeavor to get the ship and crew in as efficient a state as possible; here the apprentices are taken care of. On the other hand, suppose they join a ship nearing the end of her cruise: those already on board have become well drilled, say, and there is a let-up in the vigor displayed earlier in the cruise; hence no one takes any special interest in the new apprentice, and he is left to pick up what he can for himself. Now, how much of this will be done on a new cruiser, probably five-sixths her time in port, possibly in navy-yards? The boy's mind turns to liberty, and the pleasures on shore, and he becomes dissatisfied with the service; and because of this, and also because he sees but little real advancement in the Navy, under present conditions, he leaves the service in some way or other before he is twenty-one, or at twenty-one, not to re-enlist.

There is another difficulty under which an apprentice labors, and that is—too much is expected of him by the officers, when he is transferred to a general service ship; and the officers must forget that what training the boy has had is merely a drop in the bucket.

It has not been long since the writer saw how little exercise in seamanship is given both the men and apprentices in a squadron of modern vessels. During ten days, pulling boats, other than the barge and dinghy, were not used, except on one day when some racing took place. Steam launches were used for the reason, as stated by the captain of a fine new ship, that it was less trouble and quicker to get ashore.

A study of the systems of enlisting and training apprentices in foreign services, especially those of England, Germany, and France, will furnish food for thought. It must, however, be recognized that there is a great difference between the people of the United States and those of Europe. In most foreign services enlistments are compulsory, and it is not particularly necessary to offer any inducements, or rewards for service, or give good pay. In a republican form of government, especially that of our own, which differs materially from others, voluntary enlistment of boys and men must be produced by well-found attractions.

The United States is a peace-loving country, and her people are domestic; not yet fully developed, there are grand inducements in all branches of civil life, in fact there is an opening for every young man. There is always a demand for talent, industry, sobriety, and steadfastness. The people of the United States are patriotic, but their patriotism is that of the civil class, which is the love of the country and her institutions, and her protection in case of need.

For the Navy, then, the inducements for enlisting boys and young men must be those of positive advancement, fulfilment of ambition, with no degradation of social status in an ordinary sense. To a great degree these inducements are held out to those entering the Naval Academy; but are they for an American boy enlisting as an apprentice?

As has been often said, we cannot, in the United States, depend upon patriotism in times of peace, nor the love of the sea, for recruiting seamen. If the comparatively little pay and

uncomfortable sort of life of seamen be compared with the higher pay and comfortable homes of a similar class of laboring men on shore, if there be no advancement, beyond a certain point, to the top of the ladder made possible for them as a reward for industry, natural talents, good conduct and efficiency, the best boys and men will not enlist; and for those who do, what becomes of ambition? If there is no ambition in a man, what can we expect of him? Will such a one ever become the modern seaman we want to-day?

The statement cannot be made too emphatic that, for the American Navy, inducements for enlistment must equal those for civil trades and professions; the best in the land must enlist. We do not want those who are incapable of doing anything on shore, nor those who, by reason of their unreliability, cannot keep a position on shore. Some may state that the woods are full of men willing to enlist in the Navy. Many men are willing if proper inducements and comforts are offered; others we do not want at any price. There are now many good men in our service, both American and foreign born, and a large number who are not good men.

It will now be said, that among the inducements for boys to enlist as apprentices there should be the possibility of rising from an apprentice to admiral, and this must be the greatest spur for their ambition. We are a free and independent people, forming a nation in which all alike are equally free-born; and such a people that the humblest boy can rise and become President, Commander-in-Chief of the Army and Navy. Would it then be too unreasonable for an apprentice boy to rise and become an admiral? Some may say this is theoretically a nice way of arguing, but it can be practical also.

There is too much of that wide gulf existing between the enlisted man and the officer. Not that it is advocated that there should be familiarity between the two, or any lack of discipline. There is the military difference which *must* exist, and there is the social difference, for the time being, that must exist for military reasons. In time of war, even in peace, it has often happened that men of good social status are privates under the command of more humble-born; discipline was maintained, and mutual respect existed. It might be suggested that the grand inducement, once offered, may tend to injure any appren-

tice system, as it is claimed that it did once before, when the entry as an apprentice was made the road to a commission.

The method that will be proposed in this article is not the same. There will be two distinct roads to a commission in the line of the Navy, one through the Naval Academy, the other through the training squadron. The apprentice must rise through seaman, petty officer, and warrant officer, to a commissioned officer *without* ever going through the Naval Academy, as formerly done, and his commission will be the reward of his own exertions and worth. The service will be guarded by suitable examinations and reports. The system which is here proposed is the result of observations on board our training ships, combined with some study of foreign systems, and the thought created by the numerous essays and discussions written on kindred subjects.

The greatest inducement for parents sending their boys into the Navy having been touched upon, the next point is their enlistment and training. One of the most important parts of the training is the possession of suitable training ships. Allied to these will be a slightly different organization of the seaman branch of the Navy, as necessary to carry out effectively what is an American system—a *civil service* system, as it were; merit, morals, and good conduct to be the requirements for promotion in all cases.

Enlisting Apprentices, and Inducements.

It must be quite evident that when only ten to fifteen per cent. of the naval apprentices enlisted remain in the service, something is wrong with the system.

The source of supply of seamen for our modern Navy should be the training squadron, with possibly a limited enlistment of young men from 21 to 25 years of age, who could also be given a short course of training, as will be suggested later on.

The average annual waste of seamen in the English Navy is from 11 per cent. to 14 per cent. In our own service in 1892, out of 8,250 men and boys, 1,614 were discharged for disability, services not required, at own request, requests of commanding officers, bad conduct, illegal enlistments, inaptitude; 1,260 men deserted, making a total waste of 2,874 (not including deaths). In 1893, similar figures bring the waste to 2,719. Taking 2,800

as the waste out of 8,250, there is a percentage of over 32, which is unhealthy, being nearly three times as great as that of England, and, of course, would not last under more favorable conditions. The average number of desertions of men in 1891, '92 and '93 was 970, which is 13 per cent. of 7,500. The average number of apprentices who deserted in 1891, '92 and '93 was 330, or 44 per cent. of 750, the whole number allowed at that time.

Of those men discharged in 1891, '92 and '93, about 12 per cent. had requested it, and this, with the 13 per cent. who deserted, makes 25 per cent. of the enlisted force who left the service because dissatisfied in some way or other. Thus, 25 per cent. of the trouble of training the men, as well as 25 per cent. (nearly) of the expense, was, to a great extent, uselessly expended. These figures are a trifle large, due to some men of the Coast Survey and Fish Commission being discharged for various reasons, but that number is not large. In 1892 and 1893 the average number of men holding continuous-service certificates was 1,640, or about 22 per cent. of 7,500, and represented those contented with the service and satisfactory in ability and conduct.

The figures for 1894 and 1895 will show an improvement, which, I believe, is due to good laws relating to the men, such as "discharge by purchase," the offer of a home, or partial retirement after twenty years' faithful service, better quarters on board ship, permanent appointments for petty officers, and probably to greater interest in the new Navy. Taking the figures for 1895, 813 men and 124 apprentices were discharged for disability, services not required, at own request, request of commanding officer, bad conduct, inaptitude, discharge by purchase, etc.; 715 men and 173 apprentices deserted, making the waste as follows:—For men, 1,528, or 18 per cent. of 8,500; and for apprentices, 292, or 20 per cent. of 1,500 (supposing the above numbers represent the total enlisted force), or 18 per cent. of the 10,000 men in the Navy. Thirty-one per cent. of the men held continuous-service certificates. Thus the waste is still considerably greater than that of the English Navy in 1878.

Taking the waste as 12 per cent. of the total enlisted force, under fair conditions, 1,200 new men would be required each year, of which some 400 would be required for the engineers' force.

It would be fair to presume that 75 per cent. of the apprentices would remain in the service after reaching the age of 21 years, under a satisfactory system. This percentage would yearly amount to about 200 out of the 1,500 apprentices in the service, and would represent an annual enlistment of about 400 boys.

In the case of the officers of the Navy, taking the line, engineer, and marine corps, numbering about 1,000 on the active list, the annual waste is about 4 per cent. or less; and, in order to supply this waste, about 300 cadets are kept in training, or one-third of the total number of officers concerned. Should such a proportion obtain in the enlisted force of the Navy, we should have about 3,500 apprentices instead of 1,500, and, I believe, it would be economy in the long run, not only in the matter of expense, but also in efficiency, to make such an increase. In the English Navy, with 20,000 men in the *general* service, there are 5,000 to 5,500 apprentices.

With a reorganization of the seaman branch, and some further inducements as are proposed in this article, such that a larger number of men would obtain continuous-service certificates, or would re-enlist, the above-proposed number of apprentices would be sufficient to supply the annual waste in the seaman branch, or from 700 to 800 a year, allowing 12 per cent. for the general percentage of waste. As to recruiting the engineers' force, it is better to enlist men directly from civil life who have already had some experience on shore or at sea in similar capacities; and one modern vessel, as part of the North Atlantic Squadron, might be assigned for their instruction.

The present regulations concerning the enlistment of boys are very good, if strictly carried out. They are sections 1418, 1419 and 1420, Revised Statutes, and some rules established by the Honorable Secretary of the Navy; and are briefly as follows: "Boys between the ages of 14 and 17 years, with the consent of their parents or lawful guardians, are enlisted to serve until 21 years of age. No insane, intoxicated person, nor a deserter from the naval or military services shall be enlisted. A boy enlisting must satisfy an examining board of officers that he is of robust frame, intelligent, of perfectly sound and healthy constitution, free from any physical defects or malformation, not subject to fits or dizziness; is able to read and write English." No boy convicted of crime can be enlisted. In special cases,

where a boy shows general intelligence, and is otherwise qualified, he may be enlisted notwithstanding his reading and writing are imperfect.

The minimum age and physical standards are now such that mere children are often enlisted, and even if remaining six months at the training station, and six months on board the training ship, they are often too small to draft to a cruiser so as to be of any value. Again, there are boys, large and strong physically, who have no education and are not overburdened with intelligence, often found on board the training ship.

It has been found in the English Navy, where there are over 5,000 boys, of whom 2,500 are in special training, and in which service excellence in training her seamen has been attained, that the best age to enlist boys is from 15 to 16½ years, the latter limit not to be exceeded. For a boy 15 years old the minimum height is 5 feet, chest-measure 30 inches, weight about 100 lbs.; compared with this in our service, a boy 15 years old must be 4 feet 11 inches tall, chest-measure 27 inches, weight 80 lbs., and for boys 14 years old, 4 feet 9 inches tall, 26 inches chest-measure, weight 70 lbs.

It can very easily be seen that too early entry, or too low physical standard, works to serious disadvantage when boys are transferred to the general service ship to fill up her complement; such boys cannot do the work of men.

Again, in the English service it is found that boys over 16½ years, especially such as cannot pass the mental test, are too mature to be readily adapted to seafaring life; for minds so long dormant are less receptive to the knowledge that a modern seaman must possess. A fine physique will not of a right pass such boys into the service.

The long experience of English officers seems to bear out the above observations.

There is another thing: not sufficient attention is paid to good character and moral qualifications. Although boys may not be convicted of any crime, yet they can come from a reformatory, and such boys, incorrigible by their parents, should not be allowed in the service. The training squadron is no place for incorrigible boys, of whom parents or guardians wish to rid themselves; time and patience are too precious to waste on them. Few such boys remain in the service, simply because they are discharged, or desert, not, however, until six months or a

year has been thrown away on them. Then there is a great deal too much of this business of step-fathers and step-mothers forcing their boys to enlist in the Navy. Such boys may be intelligent, but they will not try to learn, nor will they do duty properly. We want boys who *want* to go in the Navy and make it a profession. They will succeed, and a few may be found in every draft. They grow up and make some of our best petty officers. Nothing is more exasperating to a divisional officer than to get hold of a boy who does not want to learn, or one of no intellect; hours of patient instruction are given, which goes in at one ear and out at the other. There must be a more severe weeding-out system at the training station, so that every boy coming on board the training ship means, and is fit for, business. There may be an old saying that "boys will be boys," but there is another one, "there are boys and there are *boys*." The government is paying each one nine dollars a month, and thirty cents per day for rations, to learn and remain in the service. It is suggested that inducements and regulations for enlisting somewhat similar to the following be adopted:

1. American-born boys, from 15 to 17 years of age, with the written consent of their parents or guardians, who are robust, healthy, undeformed, sound, intelligent, and of good character, may enlist in the U. S. Navy as apprentices, to serve until 21 years of age.

2. No boy, insane or intoxicated, possessing any inherent weakness, or disease affecting the health or longevity, or a deserter from the naval or military service of the United States, shall be enlisted.

3. No boy between the ages of 15 and 17 years whose height is less than 5 feet, chest measurement under 28 inches, weight under 100 lbs., even if otherwise qualified, shall be enlisted as an apprentice.

4. The enlistment of boys shall be entirely voluntary, and each boy shall, under oath, so state, as well as his parents or guardians.

5. Each apprentice shall be made to understand the meaning of the shipping articles, and take the following oath:—I swear (or affirm) that I will support the government of the United States, and will obey all lawful orders of my superior officers as long as I remain in the service of the United States; and I do renounce all allegiance or fidelity to any foreign power,

prince or potentate, and will remain loyal to the United States as long as a citizen thereof; under the pains and penalties that law may prescribe.

6. Each apprentice, on enlisting, shall be furnished gratis such outfit of clothing as may be prescribed by regulation.

7. Any apprentice, with the written consent of his parents or guardians, may purchase his discharge after six months' service, provided he refunds to the government all pay he may have received, and the value of the clothing originally furnished him, if approved by his commanding officer, as well as by the Navy Department.

8. An apprentice may, by his fidelity, intelligence, industry, obedience, and good conduct, after having served his minority, undergoing suitable examinations, and passing through the grades of seaman, petty officer, and warrant officer, in the U. S. Navy, be eligible to promotion to the lowest grade of commissioned line officer, provided he undergoes the same examination as the graduating class of naval cadets, and further provided that he shall be examined with the graduating class of the year.

9. One-tenth of the vacancies occurring each year, in the lowest commissioned grade of line officer, shall be reserved for the promotion of warrant officers. No greater number of warrant officers, who are ex-apprentices of good standing, shall be examined each year than have been suitably recommended to the Navy Department by commanding officers of ships, squadrons, or stations. Those passing satisfactorily shall, in the order of their standing, be assigned the vacancies reserved; but no such vacancy, if not filled by warrant officers, shall hold over from one year to the next, but shall be filled by the naval cadets.

10. The only grades of warrant officer eligible for advancement to a commission shall be those of boatswain and gunner, and none but ex-apprentices shall be eligible to promotion from warrant officer to the lowest commissioned grade of the line, and provided that such warrant officer shall have served at least six months at sea as warrant officer, and is not over 30 years of age.

11. A warrant officer, having received a commission in the lowest grade of the line of the Navy, shall take rank next after the last naval cadet commissioned that year, and shall, thereafter, be in the regular line of promotion.

12. All grades of warrant officer shall otherwise be filled as now prescribed by law.

Training of Apprentices.

Admiral Luce says, in his article on Naval Training (No. 3, 1890, U. S. N. I.), "The first essential in organizing a system of training is to know exactly what is to be produced. The brain, nerves, and muscles must all be trained, one is essential to the other." We want, above all things, able *petty officers*, and educated, reliable seamen for our modern Navy.

There is no profession where more manly traits are called for than in that of the seaman. He must be possessed with readiness of resource, quickness to understand, and adaptation to the demands of the moment. He is not the old sailor, who was very dependent, requiring always to be looked after. Self-reliance and resolution must be a part of his nature. In fact, he must be more like other men on shore, who earn their living by the sweat of the brow.

What will be the efficiency of a modern battleship if the guns, torpedoes, and machinery are in the hands of *untrained*, unskilled, possibly unpatriotic hands? A *trained personnel* is necessary, and the most important part of it is the petty officer, who must first be a *seaman*. Now the man possessing the brightest, quickest brain, the most trained in muscle, nerve and will-power, will naturally make the most efficient fighting seaman. The subject, then, being of so much importance, we should begin at the bottom of the ladder with the apprentice boy and make him the seaman that Americans will always be proud of.

As soon as practicable, after enlistment, apprentices should be transferred to the training station, and *there* furnished with their outfit of clothing, to be made to measure by a tailor. It often happens that ready-made clothing, issued by the Pay Department, does not fit, and is not strictly regulation, due to changes in uniform regulations, old clothing being issued first until the supply is exhausted.

The matter of always being *strictly in uniform* should be a strong point in the training of apprentices. There are too many men in the service who wear non-regulation clothing, and they are found right on the training ship, unless steps are taken at once to prevent it.

After the boy joins the training station, the first things to be taught him should be how to lash his hammock, how to wash himself and his clothing, and that "cleanliness is next to godliness."

The present system of instruction at the Naval Training Station, Newport, R. I., as instituted by Captain Bunce, U. S. Navy, when in command there, is excellent, and there are evidences of the good effects shown in the apprentices now drafted to the training ships. By General Order No. 257, of Dec. 16, 1880, the station was established on Coaster's Harbor Island, near Newport, which the State of Rhode Island had presented to the Government. It might be said the foundation of the present system of training began there. It is a great pity the station could not have been located further south, say on the Chesapeake Bay, open all the year, whereas the climate of Newport in winter is often beastly.

Apprentices are drafted from the receiving ships to Newport from time to time, and are there assigned to a division. The complete division is made up of 108 boys, forming 3 companies of 36 each; each company is divided into 2 sections of 18 each, as provided in the Infantry Tactics. A commissioned officer is assigned the command of a division, and has for his assistants three petty officers, a schoolmaster, and two masters-at-arms, say, and section masters of seamen-gunners, when practicable, who command the companies and sections, and are with them and responsible for them all the time.

The instruction consists of elementary seamanship and gunnery, reading, writing, arithmetic, geography, history of the United States, and history of the Navy. Lectures on various subjects pertaining to the Navy, foreign countries, seaport towns, etc., have been prepared and are delivered. They are instructive and of great interest to the boys.

The system is well described in the annual reports of the commandant of the training station in 1892 and 1893.

After a period of instruction of six months at the station, a six months' cruise is made on the cruising training ship.

The great feature of first having the boys on shore is that they have clean barracks, plenty of room, fresh air, fresh water to wash with, and that they are *constantly* under surveillance.

The only comments that might be made on the system used at the training station are that the apprentices should remain at the station not less than six months, and if possible from nine to twelve months, the first part of the course being devoted more especially to school instruction, setting up, and gymnastic exercises, for the purpose of developing the mind and body at

the start. More attention should be paid to schooling, infantry and artillery drills, sword exercise, boat exercise, and less to seamanship and gunnery. My reason is that seamanship and gunnery can better be taught and learned on the training ship, where schooling, infantry and artillery exercises cannot be so well attended to. The main idea, I should say, of the instruction at the training station on shore is more to *prepare* the mind and body for what comes afterwards. A boy will have little schooling after he leaves the station; his education for life may depend upon it. So let one thing at a time be thoroughly done. A good opportunity for weeding out the undesirable boys will then be given, and the service will be benefited thereby.

Six months having been devoted to schooling, developing, and *military* exercises, a beginning on seamanship might be made, and, for that purpose, one or two brigs, of about 500 tons displacement, should be provided. A division (108) could go out for the day, and have constant drill at sails, spars, heaving the lead, steering, working ship, anchoring, getting up anchor, etc. This is done in the English service, where there is a brig for each training ship, and no one who has seen those little brigs going in and out of port every day of the week, weather permitting, has failed to be favorably impressed. This latter work will be of great value to the boy when he comes on board the cruising training ship, and this training will also form the basis for the final weeding out at the station.

The next part in the boy's training is the cruise on the training ship, which is of the greatest importance; on it will turn the like or dislike of the boy for the service.

Training Ships.

On board the training ships the apprentice gets his first real impressions of the Navy, and here he should receive the most important part of his *professional* education, which must be *practical*. He is, by his schooling and previous drill, well qualified for a good start.

Too much attention cannot be paid to the size, rig, and fittings of the training ship, and especially in regard to the facilities for instruction in gunnery, torpedoes, seamanship, electricity, etc. (all practical).

At the present time we have the Alliance and Essex, two steamers, barque rigged, of 1,375 tons displacement, each of

which takes out, twice a year, 108 apprentices, and a crew of men and petty officers of 85, making a total of 193 people living forward of the mast. These ships have no gun decks. The only berthing and living spaces are the berth-deck forward of the boilers, poorly lighted and ventilated, where the 108 boys have billets, and where hammocks hang on the hooks like sardines in a box; and under the topgallant forecastle, where all the men have billets. Every one is very much crowded, and in bad weather the only place to go for the greater part of the day is under the topgallant forecastle, as the berth-deck must be kept clear for the purpose of cleaning up and setting mess tables. The ships are provided with a modern battery of 4", 6 pdr. and 1 pdr. R. F. guns, and this is about the only modern thing on board. There are few or no facilities for instruction, no models, etc., and but little of anything provided.

The vessels are kept running, and that is about all. There is no reason why every boy should not become disgusted with the service, so far as his life on the present training ship is concerned. It is difficult to turn out good material under present circumstances (I mean in a modern sense).

It is quite evident that, in order to make a success of training apprentices, at least two suitable ships for the training squadron be provided. In the English service, where better ones are provided, it is there even found that boys are not as well developed as they should be, and it is said to be due to the overcrowding of their training ships.

It must be remembered that boys are growing, and need more care than "old salts," better food, and greater facilities for exciting interest and stimulating the muscles, brain and nerves. No amount of living on board a crowded vessel, with no pleasures and few comforts, will make a boy love the sea.

Quite recently the writer was enabled to see the kind of vessels the Germans have for training their men and midshipmen, when three sheathed iron steamers, full ship rigged, each of about 2,900 tons displacement, came in port (S. M. S. Stein, Stosh, and Gneisenau). These vessels carry crews of over 400, and seem to be well suited for the purpose of training, though not quite modern.

In determining the type of ship we want, I will quote a little. Dr. F. La Grange says, "It is incontestable that certain faculties of the soul come into play in bodily exercise to excite the con-

traction of muscles and to co-ordinate movements; it is also incontestable that those faculties are improved and developed by exercise. The faculties which preside over the co-ordination of movements are developed by the performance of difficult exercises, and their improvement endows a man with the quality we call skill." Now can any one admit that such exercise can be obtained on a modern man-of-war? Gymnastic exercise, boxing, etc., are very good in a way, and possibly sufficient for men, but not for the boys we want to develop.

Admiral Luce says, referring to the sailing ship, " It is impossible for any young man to go through the school of the topman, and become an able seaman, without having his moral being permanently affected by it. Indeed, it is well known that such an experience does affect character, and has endowed the sailor with those high qualities of self-reliance, endurance, courage, and patience under difficulties, which have always characterized him."

A sailing ship would then seem to be still a very desirable thing for the training of boys, and in addition to this, we combine the knowledge gained of useful seamanship, which every *seaman* of to-day ought to know, and what every *sailor* formerly had to know. It is recognized by the best steamship companies that seamen are most easily and efficiently made in sailing ships. England, France, and Germany, countries possessing great modern navies, with skilled men to handle their ships, recognize the value of sails in the early training of boys, both for seamen and officers. If seamanship were all that is now required in training men, we would say the sailing ship (alone) is the proper type; but the training must be for fighting purposes, skill in great, rapid-fire and machine guns, torpedoes, small arms, etc., and the knowledge of modern machinery now used in modern men-of-war, which are mere workshops as well as gun platforms. We must then, in selecting a type of training ship, retain the spars and sails, but provide her with moderate steam power, using a modern type of engine and boilers; with a modern battery, small arms, torpedoes, dynamos, modern appliances, models, etc., as far as practicable. It will then be possible for a modern man-of-war's-man to be turned over to the general service at the end of the practice cruise.

It would be a measure of economy in the long run, and of marked efficiency, if two suitable training ships be built, that they

be so constructed as to render good service in case of war. The vessels at present in use might be returned to the general service, and would be valuable for some time if sent out to the Pacific. Attention is invited to some details in the design and in building of a training ship. A little experience in those used at present and formerly is sufficient to point out the needs.

Type of ship.—Single screw gun-deck steamer, ship rigged to royals, with nearly full sail power, of about the following size: length 220 feet, extreme breadth 40 feet, mean draft 17½ to 18 feet, displacement about 2,200 tons, height between decks not less than 7 feet in the clear, air ports of berth deck to be large and not less than 5 feet above the water. To be built of steel throughout, and the bottom *sheathed with wood* to a convenient height, say the gun deck. There should be a light protected deck, on which would rest the berth deck, and under which would be the "vitals" of the ship. Thus, four decks would be provided, spar deck, gun deck, protected and berth deck, and forward and after orlop decks.

General details.—The engines to be triple expansion, which, with modern boilers, would, under natural draft, be designed to drive the ship at a maximum speed of 12 knots and an economical speed of 8 knots. Donkey boilers should be located in the fire-room for working the steam capstan, dynamos, blowers, flushing pumps, and cranes for hoisting the launches. Evaporating and distilling apparatus, capable of producing 2,000 gallons of fresh water *per diem*, should also be located in the fire-room compartment. The fore and main masts, fore and main yards, and the bowsprit might, for reasons of strength and lightness, be built of steel. The standing rigging should be steel wire rope. The ship should be provided with steam (and hand) capstan, steam and hand steering gear, dynamos, blowers for ventilation, and an ice machine for cooling drinking water. Two bridges should be provided on the spar deck, one aft, for use when under sail (on which might be located the standard compass), and under which would be the hand steering wheel, with steering compasses; one forward, for use when under steam, which would be provided with a chart house, on which would be the steam steering gear, engine room indicators, and a compass. Both bridges should be of such height that a view over the boats would be possible.

The boats should be large enough and sufficient in number

to carry the whole crew with ease, and might consist of three cutters stowed on skids over the quarter deck, between the after bridge and main rigging; two whale boats, which could hang from davits at the ends of the quarter deck boat skids, and could be rigged in, or from davits (folding) on the quarters; one sailing launch and one steam launch, to be stowed on half skids in the waist abreast the smokestack, each to be hoisted by a crane or derrick, worked both by hand and steam power; one gig to hoist aft, one dinghy, and one shell boat (for use of officers), to be stowed in the sailing launch at sea, and to hoist on davits abreast the mizzen rigging in port. The cutters and whale boats might be of the same length, provided with suitable detaching apparatus, and built with oarlocks low enough for boys.

In order that the ship might sail as well as possible, the screw should uncouple well aft, and a false keel of wood, extending one to two feet below the keel of the ship, should be provided.

Battery.—Two 6-inch R. F. guns, mounted on the forecastle and poop on the midship line; two 5-inch and six 4-inch R. F. guns, mounted on the gun deck in sponsons, and as opposites (5" guns forward); six 6-pdr. R. F. guns, two to be mounted in the after cabin, the others between the four-inch guns in suitable sponsons; two 47 mm. revolving cannon, mounted on the forward bridge; two machine guns, mounted on the after bridge; two field 6-pdrs. All guns on spar deck to be provided with shields. Different service mechanisms should be represented in the battery. Boat and field carriages for the revolving cannon and machine guns should be provided. The idea is to have a battery as diversified as possible to give more room for instruction. The latest type of modern small arms should also be provided for instruction, though for drill, older types might be used for economy, as boys give these hard usage.

Torpedoes.—Two torpedo tubes should be provided, one on each bow, with carriages on the berth deck, and located in a roomy, water-tight compartment, which would also be used as a torpedo schoolroom and workshop. One Whitehead and one Howell torpedo should be provided, with spare parts and appliances for use and instruction of apprentices.

Location of quarters, store rooms, etc. On the gun deck.—Aft would be the cabin, divided into forward and after cabins, provided with two staterooms, with adjoining bath rooms and w. c. arrangements, and a cabin pantry amidships, for-

ward of cabin bulkhead. On the port side, forward of the cabin, should be located two roomy staterooms for the executive and navigating officers, with their offices. On the opposite side, and taking up an equal space, should be the library and reading-room, provided with an excellent assortment of books, tables and easy chairs. Forward in the waist on one side between two guns, might be located the armory and ordnance model room, in which should be a good assortment of models of guns, mechanisms, etc., fuses and appliances for the instruction of apprentices. On the opposite side might be located the crew's library. The ship's galleys and bake oven should be located forward in a light, open steel room, amidships abaft the foremast. The crew's water closets would be at the forward extremity, in a compartment, and a special place provided for petty officers. On this deck all the apprentices would have billets. *On the berth deck.*—All that part abaft the mainmast would be given up to the ward room and warrant officers, and divided into four compartments, as follows, beginning aft:—Ward-room bath-room compartment, which would contain bath-tubs, lavatories and water closet arrangements, and should be well ventilated and lighted with an air trunk to the spar deck; ward-room stateroom compartment, in which would be fourteen comfortable rooms opening into a central alley-way, provided with a light and air trunk to the spar deck. Each room should be provided with a ventilator, electric light and suitable furniture; a small stairway might lead to the gun deck; ward-room mess-room compartment, which would run from side to side, be provided with table, sideboard, etc., and a skylight; steerage compartment, in which would be located four warrant officers' staterooms, warrant officers' mess-room, pay office, ward-room and warrant officers' pantries, and a room for stowing officers' rain clothes; into this compartment would lead a hatchway from the gun deck, through which would lead engine-room trunk, and from which would lead a hatchway to the after orlop deck. Forward of the latter compartment would be the berthing space for the men, which should contain an apartment similar to the old steerage for the chief petty officers, a bath-room for the men, sick-bay, wire bag lockers out at the sides and amidships for the crew, and the blowers. The main hatchway should come out just forward of the steerage com-

partment, the fore hatchway forward of the fire-room trunk. The torpedo-room would be located at the forward end.

Under the protective deck.—Beginning aft might be the steering engine compartment, which would end the orlop deck; store-room compartment, where would be located the paymaster's stores, cabin, warrant officers', ward-room officers', and ordnance stores; engine room compartment; fire-room compartment; forward orlop deck, as far as the foremast; fore-peak and collision compartment. The sail rooms and equipment store-rooms should be located on the orlop deck, just forward of the fire-room; they could be converted into coal-bunkers in case of war. The ordinary coal-bunkers could be located outboard of the engines and boilers. Below the orlop decks would be fore and main holds, where would be the wet provisions, water tanks, and ammunition rooms. The dynamo room might be on the after end of the forward orlop deck, next to the fire-room.

Electric plant, located as above, should consist of two similar dynamos of sufficient power to run the incandescent lights and one search light. The dynamo room might be made a little larger than those of modern cruisers, to give more *room* for the instruction of apprentices. The ship should be provided with most of the modern electrical adjuncts, especially the apparatus for signals, as signaling is an important part of the apprentice's instruction; spare material, models and samples of different electric gear should be provided for instruction.

Too much importance cannot be attached to the value of a covered gun deck, for room, health, comfort, as well as a good protected battery platform. It also provides a large school-room for the apprentices, especially valuable in bad weather.

As the above type of ship will not have such high powered engines as the modern racing cruiser, the cost will not be so great, and there will be a great deal more room. The steam power is intended only as an auxiliary to be used in going in and out of port when necessary, or otherwise used in case of necessity; but is of sufficient power to make the vessel a fairly efficient steamer. By having two such vessels built at the same time, probably $450,000 would cover the cost of each exclusive of the cost of the battery.

The importance and value of some such vessels to the training service, to make the latter a success, should be sufficient warrant for Congress authorizing their construction.

THE CRUISE OF THE TRAINING SHIP, AND SYSTEM OF INSTRUCTION.

In the English service, about 16 months are spent in training apprentices before transfer to general service. At the present time our apprentices are, as a rule, transferred at the end of about 12 months. In that short time, one would hardly believe that sufficient instruction and experience can be obtained, when the fact is taken into consideration that but little special instruction is given the apprentice on general service vessels. In addition to the course at the training station, above referred to, a continuous cruise of 10 months would seem to be desirable, thus giving each apprentice from 16 to 22 months' experience.

Admiral Luce says in his article on Naval Training, "The cruise of training ships should always be to foreign ports . . . Hanging around the coasts and inland waters, and anchoring every evening or two, so that all hands may enjoy a night in, is very pleasant, but it is not business . . . By letting the ships cruise singly with a view to their meeting at a certain time under squadron organization for competitive exercises . . . the best results may follow. The spirit of rivalry stimulates each one to do his best." It is easily seen that a foreign cruise is better than one on our coasts for two principal reasons: first, because the boys will take greater interest and will have a chance to see something, getting varied experience, and second, because the great annoyance of applications for leave, and desertion will be avoided.

At present our training ships make two cruises a year, of five months each, to Europe or the West Indies, according to the season, and spend the greater portion of the time actually at sea, but cruise singly. Under the proposed system a long sea cruise is better, as previous preparation at the training station is somewhat modified. As it is at present, shorter cruises, with more time in port, would be of slight advantage.

It is suggested that the two ships cruise singly for the first six months, making a cruise to Europe, leaving the United States about May 1st. About Nov. 1st they would return to Yorktown, Va., or Port Royal, S. C., for *target practice*, spending a month at both stationary and moving practice with the great and secondary guns, and the small arms as provided by regulations. Each boy should have an opportunity to fire a gun of the main or secondary battery, the most proficient in stationary practice to fire at moving practice. This is a very important

part in the system of instruction, as the skill in handling the guns effectively is the most important of a seaman's accomplishments.

About Dec. 1st the two ships should sail together in company for a three months' cruise to the West Indies, and remain in company until the return to the United States and the annual inspection. The apprentices thus gain their final experience in the training ship.

After a leave of absence of about two weeks, such boys as are qualified in every respect for transfer to the general service should be transferred, and the remainder discharged from the service. Two months would then be available for overhauling and repairing the ships for the next cruise. Thus there would be one cruise each year, and the two vessels above suggested would be large enough to take all the apprentices enlisting each year, with the present number allowed by law.

There have been, in general, two systems of instructing apprentices on board the training ships. 1st. Each watch officer was made the head of a department of instruction, being aided by the warrant officers and a schoolmaster for each gun division. In this system each officer instructed and examined all the apprentices in his own department, thus ensuring *uniformity* of instruction, which is an important thing, and the possibility of knowing the backward boys better and giving them further instruction. By a rotation of divisions, and with a sufficient number of assistants, only a small number of boys would be instructed at a time. The second system (the one now employed) is what might be called the "divisional system," in which each division officer instructs his own division in everything. It lacks the greatest advantage of the first system, *uniformity of instruction*, and besides, where all are taught the same things, there should be a division of the labor. Apparently it is unsuited for ship work. On the present training ships there are *no assistants* except the seamen petty officers of the ship, who are supposed to instruct in marlinspike seamanship. These petty officers are not paid for this kind of work, and often perform it reluctantly, and not well.

Experience with both systems is convincing enough, at least under present conditions, that the former is better, and it might be suggested that a similar system be used.

Schoolmasters are very valuable on board a training ship (not *shore* schoolmasters, but men-of-war's-men), and their importance cannot be overestimated. They are more valuable even

than junior officers, as they are in constant charge of, and in contact with, the boys of their own divisions. They perform duties that it is not proper that an officer should perform and preserve the dignity that will always insure ready obedience. An officer must not have too much contact with the enlisted men, a little aloofness is better. The schoolmasters are men paid for the work they do, and if selected with some care, good results will follow. Even if they were allowed, there would be no room for them on board the present training ships.

The following division of the labor of instruction and arrangement is a modification of the first system, and would, I believe, produce good results:

1st watch officer. Head of 1st department of seamanship. Includes rigging, sails, spars, marlinspike seamanship, ship's economy, and models. Assistants: the boatswain, sailmaker, carpenter, and schoolmaster of division.

2nd watch officer. Head of 2nd department of seamanship. Includes boats, lead, log, compass, and rules of the road. Assistants: junior officer of division and schoolmaster.

3rd watch officer. Head of 1st department of gunnery. Includes great and secondary guns and target practice, torpedoes, magazines, ammunition rooms, and models. Assistants: junior officer of division, the gunner, and schoolmaster.

4th watch officer. Head of 2nd department of gunnery. Includes machine guns, small arms, subcaliber and small arm target practice, gymnastics, broadswords, etc. Assistants: junior officer of division and schoolmaster.

5th watch officer. Head of department of electricity and signals. Includes electric plant and signal instruction. Assistants: junior officer of division, schoolmaster, and electricians.

In the daily routine of instruction a certain amount of freedom should be allowed the division officer, and, accordingly, special drills should not, as a rule, be specified in such a routine for each period, that being left to the discretion of the instructor. A whole day should be allowed for a subject for each division, as the mind of a boy will not be confused by varied instruction, and can better retain what is taught than when each period is assigned to a different department of instruction. Thus, there would be five departments of instruction, five divisions of boys, and five days in the week for instruction, allowing a complete rotation for each week. The following routine is based upon the above remarks and those lately used on the ship:

DAILY ROUTINE.

	First Div.	Second Div.	Third Div.	Fourth Div.	Powder Div.
Monday.					
1st Period 9.30 to 10.30	Weekly	routine for	all hands.		
2nd Period 10.45 to 11.45	1st Seamanship	2nd Seamanship	1st Gunnery	2nd Gunnery	Electricity or Signals
3rd Period 1.30 to 2.30	"	"	"	"	"
4th Period 2.45 to 3.45	"	"	"	"	"
Tuesday.					
1st Period	Weekly	routine for	all hands.		
2nd Period	2nd Seamanship	1st Gunnery	2nd Gunnery	Electricity or Signals	1st Seamanship
3rd Period	"	"	"	"	"
4th Period	"	"	"	"	"
*Wednesday.**					
1st Period	Weekly	routine for	all hands.		
2nd Period	1st Gunnery	2nd Gunnery	Electricity or Signals	1st Seamanship	2nd Seamanship
3rd Period*	"	"	"	"	"
4th Period*	Sewing	and mending.	Bag inspection.		
Thursday.					
1st Period	Weekly	routine for	all hands.		
2nd Period	2nd Gunnery	Electricity or Signals	1st Seamanship	2nd Seamanship	1st Gunnery
3rd Period	"	"	"	"	"
4th Period	"	"	"	"	"
Friday.					
1st Period	Weekly	routine for	all hands.		
2nd Period	Electricity or Signals	1st Seamanship	2nd Seamanship	1st Gunnery	2nd Gunnery
3rd Period	"	"	"	"	"
4th Period	"	"	"	"	"
Saturday.					
Forenoon.	Cleaning stations for all hands.				
Afternoon.	At sea, sewing and mending. In port, watch to have liberty, according to class. Holiday.				
Sunday.					
Forenoon.	Commanding officer inspects. Church. Library books.				
Afternoon.	At sea, library books. In port, watch to have liberty, according to class. Library books.				

*In port on Wednesdays all first class boys have liberty.

WEEKLY ROUTINE OF EXERCISES. AT SEA. 1ST PERIOD.

Monday. Sail exercise, or manœuvre ship. All hands.
Tuesday. Stations, arm and away boats, abandon ship, up provisions.
Wednesday. Spar exercise, or manœuvre ship. All hands.
Thursday. Company, or battalion drill.
Friday. Clear ship for action, general quarters, fire quarters.

WEEKLY ROUTINE OF EXERCISES. IN PORT. 1ST PERIOD.

Monday. Sail exercise, all hands.
Tuesday. Boats under oars or sails.
Wednesday. Out all boats, arm and away, or abandon ship.
Thursday. Company, or battalion drill. (On shore, if practicable.)
Friday. Aiming drill, subcaliber practice, torpedoes.

SUNSET ROUTINE. AT SEA.

Reef topsails, or shorten and make sail, or down and up light yards.
15 minutes setting up, or developing exercise.

SUNSET ROUTINE. IN PORT.

"Down light yards," once a week "down topgallant masts," once a quarter "house topmasts."
15 minutes setting up, or developing exercise.

7.30 A. M. ROUTINE. IN PORT.

Up yards, or masts, or "loose sail" (furling when convenient).

QUARTERLY ROUTINE.

Examinations. Change Stations.

SEMI-ANNUAL ROUTINE.

Target Practice, Great Guns and Small Arms.

On the ships above proposed, by reason of plenty of room, a sheltered gun deck, possession of torpedo and dynamo rooms, ordnance model room, a varied battery, modern ammunition rooms, square rigged mizzen mast, signal apparatus, etc., the routine could always be carried out except possibly during heavy gales at sea.

Special instruction in gunnery and dynamos, signals, sailmaking, carpentry, and blacksmithing should be given to apprentices showing special aptitude in each, and when they are transferred to the general service, the papers should specially indicate in what branch they are most proficient. There should be substantial annual prizes for the boy on each ship who is most proficient, or has the best conduct, and some such medal as the "Bailey" medal, for which the best boy on each ship could compete. These would be another spur to do well.

Amusements and Non-Professional Instruction.

In the case of boys, all work and no play is a bad thing, for they will lose interest. Each training ship should be provided with an organ, and one evening a week, say, during an hour in the second dog-watch, the apprentices should be allowed to sing national and distinctive songs, some one accompanying on the organ. Besides, an organ would be valuable in Sunday morning service. A few musical instruments might be provided, and any of the crew, who have the talent, allowed to form a band and given opportunity to practice and play. This is the case on board some foreign training ships, especially the German, which have good volunteer bands.

Lectures on Biblical history, naval history, ships, foreign countries, etc., might be prepared and delivered by the chaplain on Sunday evenings, as is done at the training station. Magic lanterns could be used to good effect. Boat racing should be encouraged, and games of foot-ball and base-ball allowed at times when in port.

A good library should be supplied for the use of the apprentices, and works of fiction, story, travel, as well as professional and scientific works, supplied. Books are cheap now, and cheap paper and binding are all that is necessary. In fact, it is only necessary to advertise in some large city for contributions of books, magazines, etc., and cartloads will be given.

The apprentices will be far more contented in this way, will take more interest in their duties, and will learn more. So in this connection is again seen the need of suitable training ships. It is difficult to provide anything in the way of amusement on the present vessels.

It might not be out of place to say here that special food should be provided as is now the custom, but it should be *better* than the naval ration if possible, and more adapted to boys' tastes. This will help to produce contentment, as some say the "heart is next to the stomach."

DISCIPLINE.

The apprentices must be under constant surveillance, and besides a schoolmaster for each division, should be a master-at-arms. The latter would swing on the gun deck with his division

to preserve order and correct any evil doings. Besides, these masters-at-arms would constitute the police of the ship, and could stand regular corporal of the guard watch, especially in port.

Quoting from the present regulations, "The discipline on board the training ships must be enforced with firmness and consistency. Mild means may be employed at first, to be followed by severe measures if the former fail to correct offenses." Now, the severe measures require an offense to be committed three times in many cases. Demerits may be very well to establish conduct classes, or to be included in a multiple of marks, say, but will not correct very mischievous boys, neither will the ordinary "extra duty." For the offenses of "Positive disobedience of orders," "Gross insolence and disrespect," "Lying," etc., for the first offense twenty demerits and four hours extra drill are given, and for the *third* offense in any one quarter, forty demerits and eight hours extra drill. Any boy on coming on board a training ship should know right from wrong, and for such grievous offenses as the above nothing but "bread and water" or "irons" can have any lasting effect. There is the possibility of being too mild. Summary court-martials should not be spared for aggravated offenses, and a "bad conduct discharge" should follow *incorrigibility*.

In this connection a strict discipline with the *men* should be maintained. Every bad thing on board the training ship cannot be laid at a boy's door; the men's example goes a great way.

Disposition of Apprentices on Transfer.

As far as practicable apprentices should be transferred to vessels just fitted out, or on the first part of a cruise, for reasons already given. It would also be well to have them in a special division, or divisions, on the service ship, in charge of officers who would continue the instruction until they become sufficiently acquainted with the ship on which serving, and her fittings, to be distributed to all divisions, and, when so transferred, they should be advanced in rating according to their value.

Officers for the Training Ships.

Taking the ships proposed, besides the commanding, executive and navigating officers, there should be five watch officers,

five ensigns recently graduated, one engineer officer, one surgeon, one paymaster, one chaplain, one boatswain, one gunner, one carpenter, and one sailmaker. The first eight line officers should be carefully selected from those having plenty of actual sea service according to grade, and the duty should be, as far as practicable, voluntary, as the duty is hard in many respects. The five ensigns detailed as junior officers would be on their first cruise, one being assigned to each division. By reason of their familiarity with the drills and details, they would be of considerable assistance to the division officer, and would be gaining experience on the sailing ship, standing day watches. This experience is good for all officers, and Admiral Luce says, "The fact must not be lost sight of that the practice ships, though intended primarily for the training of the naval apprentices, are, at the same time, an admirable school of practical seamanship for the young officers who go out in them."

All commissioned officers on the training ship would be in the ward-room.

Regarding this duty, I have heard it remarked that some officers at the Navy Department have said that duty on a training ship is *fancy duty*. Of course, no one who makes such a remark has ever been at sea in a training ship, and possibly not much in any. These ships spend more time at sea, during a summer cruise, than some ships of the New Navy do in three years. Special concessions should be made to those on this duty.

Permanent Crew for the Training Ship.

The rule is at present to select general service men who have the best records and send them to the training ship for the permanent crew. Unfortunately we do not always find good men amongst them, and it is difficult at times to make changes. As the boys get many impressions from them, it is not well to have men who are over-fond of cursing, swearing, using foul language, getting drunk, smuggling liquor, who are disobedient and disrespectful; but such are found even among the chief petty officers. There is no intention of running down the men of the service, but black sheep exist everywhere. Only such petty officers and men should be carried as are necessary to the thorough training and control of the boys, and to handle the

ship in an emergency, or during the time when no boys are on board. The engineers' force need only be large enough to enable the vessel to steam two days without serious inconvenience. The total number of men necessary on a ship as described would be about 110, including servants. These, with a complement of 216 boys (two training station divisions), would make a total of 326, which such a ship could easily carry. The necessity of having one schoolmaster and one master-at-arms for each division has already been referred to. There should also be a coxswain for each boat, and at least one seaman in each division (part of ship) for each watch.

Seaman Branch of the Navy.

The Navy Department has recently made some very good changes in the classification and pay of the enlisted men; and I believe that this fact, in connection with the laws allowing discharge by purchase, provision for pension, or retirement after 20 years' faithful service, permanent ratings for petty officers, have been of much benefit, and the records should show it.

In order fully to carry out the scheme of promotion by merit, beginning with the naval apprentice, and further to strengthen the training service, the writer would suggest some further changes in addition to the twelve articles under the head of "Enlisting Apprentices, Inducements," and such laws as are now in force.

Starting at the bottom of the ladder, the following classification and rules might be an improvement.

Boys enter as 3rd class apprentices, and, after six months' service on a training ship, may be rated 2nd class apprentices, if qualified. On transfer to the general service, those having a percentage of 85, and otherwise qualified, may be rated 1st class apprentices; and there will be a further promotion before attaining majority and discharge, to "Seaman Apprentice," who will have the same pay as a seaman; but such a one must be *able to perform a seaman's work.* All apprentices honorably discharged, on the expiration of minority, should be able to re-enlist within one year as "Trained Seamen," but will not have the benefits of continuous service unless they re-enlist within three months, as now required. The pay of a "Trained

Seaman" might be $3 per month greater than that of seaman. The rate of seaman gunner might be abolished, as well as special training on shore, except for warrant officers (acting).

Instead of having three classes of petty officers, it is suggested that two are sufficient, as the difference in pay between 1st and 3rd classes is too great, when the same duty is performed. The following rates should be established:—2nd and 1st class electricians, chief electricians, 2nd and 1st class gun captains.

The electricians will have charge of the dynamos and electric gear, and should be qualified to do all electrical work. Gun captains will perform the duty the name implies, and should be first-class marksmen.

No seaman should be rated as petty officer until he qualifies before a board of officers, who may be designated by the commanding officer; nor should any petty officer receive a higher rating without so qualifying. The appointments (acting and permanent) should otherwise be made as now provided by Navy regulations.

The following table shows, in convenient form, the proposed classification and pay of the *seaman branch:*

Chief Petty Officers.	Monthly Pay.
Chief Masters-at-Arms,	$70
" Boatswain's Mates,	60
" Gunner's Mates,	60
" Quartermasters,	60
" Electricians,	60
Schoolmasters,	60
Petty Officers, 2nd Class.	
Masters-at-Arms,	35
Boatswain's Mates,	35
Gunner's Mates,	35
Quartermasters,	35
Electricians,	35
Gun Captains,	35
Coxswains,*	30

Petty Officers, 1st Class.	Monthly Pay.
Masters-at-Arms,	$40
Boatswain's Mates,	40
Gunner's Mates,	40
Quartermasters,	40
Electricians,	40
Gun Captains,	40
Seamen, 1st Class.	
Trained Seamen,*	27
Seamen,*	24
Seaman Apprentice,	24
Apprentices, 1st Class,	21
Seamen, 2nd Class.	
Ordinary Seamen,	20
Apprentices, 2nd Class,	15
Seamen, 3rd Class.	
Landsmen,*	16
Apprentices, 3rd Class,	9

*Coxswains of steam launches, and barges, of commanders-in-chief, seamen in charge of hold, landsmen as lamplighters or Jacks of Dust, shall receive $5 per month additional.

Other laws now in force relating to classification and pay do not suggest any change.

Any petty officer of the seaman branch should be able to transfer from one rating to another in the same class, on passing the special examination. There should be uniformity in the

examinations, and to that end the Department might establish the requirements for each grade.

By adopting the changes as proposed in this article, or some similar scheme, it is believed that a staple class of efficient petty officers would soon be formed, men whose opinion could be sought by the commissioned officer, as it is done in the Army. This class is necessary to a sound organization, and when upheld, given privileges over and above those of seaman, and *not made one of them*, held strictly responsible in carrying out orders, etc., we will obtain the end so long desired. All the training of apprentices is to a great extent to get good petty officers as well as seamen.

Under the proposed general system, every boy, every man will have an *incentive* to go ahead; each one will be able to have ambition, and fulfil that ambition by his own exertions. There will be a reward for each good step.

Question as to Source of Supply.

In case the number of apprentices is not increased to about 3,500, it will be necessary to continue enlisting adults who have never served before, and it is often difficult to teach these enough, as they are too old to learn. Such being the case (with the exception of those enlisted for special service), it is suggested that young men from 21 to 25 years of age, of good education and character, might be enlisted, and sent on board the training ships, and given the same course of instruction for the first six months, those qualifying at the end of that time being transferred to the general service as "Trained Seamen," seamen, or ordinary seamen, according to qualifications.

Some similar system obtains in foreign countries. Of course, in France and Germany, say, where the service is compulsory, the early training of boys is not such a marked feature, and so-called volunteers, men from maritime inscriptions, and conscript landsmen are taken in training, and have a chance to develop taste and aptitude for the naval service, and profit by their industry and talent.

It is urged, however, that for seamen in our service the main dependence be placed on the apprentice system as the cheapest and best in the long run, provided some endeavors be made to foster it.

Conclusion.

The writer believes that this article is not as pointed as some might have made it, but from having spent a little time in the training service, recognizing some of its needs, and knowing that the present system does not furnish us with seamen and petty officers as we would have it, an honest endeavor is made to improve the service, if possible, and it is hoped that every one who reads this article will so take it.

America's bright naval record must never be tarnished. Our Navy must be and is, I believe, to-day the backbone of the country in her relations with foreign powers, to uphold the honor of the country and protect the interests of the private citizen.

DISCUSSION.

Rear-Admiral Stephen B. Luce, U. S. N.—This is an interesting paper, and shows a just appreciation of the great importance of the naval-apprentice system and its bearing on the question of manning the ships of our Navy with carefully trained American-born seamen. But while the author states the conditions of the problem, he fails to solve it.

In his introductory remarks the author observes that notwithstanding the number of essays on the personnel of the Navy which have appeared within the last few years, the subject of the naval apprentices "has been left pretty much where it stood." In this he is correct. He then expresses the opinion that "the present system of dealing with apprentices and their disposal after leaving the training-ships should be greatly modified or abandoned." He is right again. Further on, page 269, he says, "It must be evident that when only ten or fifteen per cent. of the naval apprentices remain in the service something is wrong in the system." Here the essayist is undoubtedly correct; there *is* something wrong. He concludes, on page 294: "It is urged that for a supply of seamen the main dependence be placed on the apprentice system as the best, 'provided some endeavors be made to foster it.'" Therein lies the gist of the whole question: provided some endeavors be made to foster it.

Why endeavors are *not* made to foster it, or why such endeavors as may be made to foster it are futile, is explained on page 580, No. 46 of Proceedings of U. S. Naval Institute, article Naval Administration. *It is our system of naval administration that is at fault.*

On page 293 the essayist declares that "No seaman should be rated as a petty officer until his qualifications have been examined into by a board of officers." But he fails to give any hint as to the means by which seamen may be enabled to qualify themselves for the higher duties of

petty officers. It is the gunnery-ship. The training of seamen for the Navy can never produce satisfactory results until we have a floating gunnery-ship. The floating gunnery-ship is, or should be, the Normal School of our training system.

By a "floating" gunnery-ship is meant a ship, not imbedded in mud nor permanently chained to the shore; and one devoted to the exclusive object of instructing seamen in practical gunnery, practical torpedo work, and cognate branches. Unfortunately the same cause which prevents the development of the apprentice system—a radically defective method of naval administration—operates against the maintenance of a gunnery-ship. This, also, is explained in No. 46, Proceedings U. S. Naval Institute, page 579, article Naval Administration.

The history of the several failures to establish a gunnery-ship on a permanent basis illustrates some of the peculiarities of our system, or rather of our want of system.

In 1858, Commander, the late Rear-Admiral, Dahlgren fitted out and commanded the sloop-of-war Plymouth as a gunnery-ship. She served the purpose well, but was soon discontinued. One bureau, or a fractional part of the Navy Department, could not keep her going.

On June 28th, 1881, the Navy Department issued General Order No. 272, for "the further development of the training system." Paragraph I. ran as follows: "Apprentices who have been discharged with a continuous-service certificate as seamen, and who shall re-enlist for five years, within three months after such discharge, may be admitted to the gunnery school for instruction in gunnery."

Par. II. "The gunnery school will be established on board such vessel or vessels, connected with the training station, as may be hereafter designated, and will be termed the gunnery-ship." Then follow certain regulations concerning the gunnery-ship and seamen gunners.

In pursuance of the policy lined out in this order the Minnesota, then stationed at Newport as one of the training squadron, was designated as the gunnery-ship. And to show the high estimate placed upon this advanced course and upon the rating of seaman-gunner, which was to be the reward of success in passing the examinations on the termination of the course, the rating (seaman-gunner) was placed at the head of the list of seamen petty officers, with the pay, for those who had served for two years as such on board a sea-going vessel, of $33.50 per month, at that time a comparatively high pay.* This was one of the "inducements" held out to the apprentices. It was the stepping-stone to the grade of warrant officer.

The Minnesota was no sooner organized as a gunnery-ship than she was sent to New York, tied up to a wharf, and converted into a receiving-ship for naval apprentices. Seamen were thereafter to be trained on shore, in everything and anything but gunnery, and the pay of seaman-gunner was cut down to $26.00 per month.† This was failure number two.

* See Navy Register, January 1, 1883, page 5.

† In the discussion on NAVAL TRAINING, page 409, No. 54, U. S. N. I., Boatswain Sweeney, U. S. N., in answer to the question, "How are seamen-gunners to be induced to remain in the

In his annual report of 1889, the Secretary of the Navy stated that the Lancaster had been recently surveyed, and ordered to be repaired for use as a gunnery-ship. He recommended that the number of apprentices be increased from 750 to 1500, and continued: "At the same time, the course in the training-ships should be extended by the formation of a special class for training in gunnery on board a ship devoted exclusively to this purpose. The incalculable importance of giving to enlisted men this training, especially in view of the change in naval armaments that is now in progress, has induced me to set apart the Lancaster as a gunnery-ship; and I strongly urge that authority be given to procure for her at once a modern battery."

In response to this wise recommendation, Congress made a liberal appropriation, some $200,000, and as soon as the ship was ready for the duty for which she was designed and fitted out, she was forthwith sent to the East Indies! This was failure number three.

On her return from that cruise she was again fitted up for a gunnery-ship.

In his report of Nov. 27, 1895, the Secretary of the Navy wrote that "the Alliance and Essex, training-ships for naval apprentices, had made their usual cruises," and that "the Lancaster had been assigned to similar duty." The Chief of the Bureau of Ordnance reported (1895) that the Lancaster had been fitted with a modern battery; and, further, that "if the exigencies of the service will permit the Lancaster to be used as a gunnery training-ship (the purpose for which she is intended), much good will accrue to the service." But the "exigencies of the service" did not permit, and as soon as she was ready to enter upon her duties as a gunnery-ship she was straightway sent to the Brazils! Such was the fourth failure!

The history of our naval-apprentice system furnishes similar illustrations of some of our peculiar methods. Established in 1875, it is to-day, in the matter of supplying seamen for the Navy, "pretty much where it stood," to quote the essayist once more. The following remarks, written by the Secretary of the Navy seven years ago, point out one of the evils and suggest the remedy:

To meet the want of trained American seamen, the naval-apprentice system was established. The Department, at great labor and considerable expense, has steadily improved this system, until at the present time it turns out apprentices of excellent quality. From all this, however, the Navy derives little benefit. All terms of enlistment of apprentices now expire at twenty-one years of age. When they reach this point the majority of them leave the service forever. They have received an education at great expense to the Government, and yet have been too short a time in the service to have formed an enduring attachment to

service?" answers that it is merely a question of pay, which he illustrates as follows: "Of six seamen-gunners of the same class sent to a ship, *one will, in all probability, be rated electrical machinist at $70 per month; one an armorer, at $45; and the four others may get the rates of oilers or water-tenders at $36 and $38 respectively.*" We learn from this the significant fact that the effect of training seamen on shore is to convert them into *machinists*. "Seaman-Gunner" is therefore a misnomer. The title should be *Seamen-Machinists*; or, simply *Machinists*.

it. They carry off with their discharge the benefits of the Government's outlay, and apply them to the pursuit of other careers. *The Government educates them as boys to lose their services as men, and the result is that while we have provided an elaborate system of training, we are forced to depend for seamen on an untrained service largely composed of foreigners.*

The plain remedy lies in a statutory extension of the term of enlistment to twenty-four years of age. During the additional three years, the formation of associations and a mature judgment will lessen the inclination for change, and the Government will get the services of those whom it has trained, for at least one full cruise. In the English Navy, the adoption of a rule retaining those who enlist as boys until the age of twenty-eight or thirty has completely changed the character of the enlisted force.

Here we find the Secretary of the Navy himself taking part in the discussion of this very important question; but nothing was done to correct the well-recognized evils. The naval-apprentice system is still "left pretty much where it stood." Short-term service, small pay, and misdirected (not "an elaborate system") training, due to a certain aversion for ship-life, go on just the same, and result in the very small percentage of apprentices who re-enlist after attaining their majority.

The essayist very properly condemns the practice-ships Alliance and Essex, and declares that they are enough to disgust the boys with the service. "It is difficult," he says, page 278, "to turn out good material" —apprentice boys—"under present circumstances." He then, somewhat illogically, extols the barracks plan. "The great feature of first having the boys on shore," he says, "is that they have clean barracks, plenty of room, fresh air, fresh water to wash with, and that they are *constantly* under surveillance." Would not the pleasant life, under such circumstances, supplemented by field sports and the rest of it, result inevitably in intensifying the "disgust" of the apprentice for the "poorly lighted and ventilated" accommodations of the training-ships, "where hammocks hang on hooks like sardines in a box"? There can be no question on that point. It would. The true and only way to begin the "breaking-in" process of the naval apprentice is to put him on board a stationary school-ship at once. With a properly fitted-up school-ship there would still be the "great features" of *a clean ship—plenty* of room, fresh air, fresh water to wash with, and the boys be under "*constant* surveillance," with these additional advantages that the apprentice would be initiated at the very outset into the mysteries of his new life, and be all the better prepared for the discomforts of the cruising training-ship.

On board the stationary school-ship the apprentice makes a fair start; in barracks he makes a false start. On board the school-ship the first and most lasting impressions are connected with life on the water and association with the better class of seamen; in barracks the first impressions are connected inseparably with the attractive features of life on shore and with soldiering. In short, the one method makes sailors; the other makes anything but sailors. It is this constant hankering for the shore that is one of the crying evils of the U. S. Navy to-day.

When barracks for naval apprentices were first proposed it was gen-

erally understood that the apprentices were to be quartered on shore in "light, well-ventilated" rooms for the first six months after enlistment. During that time, by some occult method, not fully explained, the bad habits, if such there were, of 16 years, the average age of the apprentice, were to be so thoroughly eradicated that the advantages of the barracks might thereafter be dispensed with. The boys could then be sent to sea with their morals sufficiently safeguarded. But if six months of barrack-life can produce such a wonderful effect, certainly an extension of time would be desirable. Hence we find the essayist saying, page 276, "The apprentices should remain at the station not less than six months, *and if possible, from nine to twelve months* . . . for the purpose of developing the mind and body at the start." Here we see plainly the marked partiality for the shore—the disposition to extend the time on shore, and the specious reasoning in support of it.

The light and airy quarters of the barracks, the gymnastic exercises, the infantry and artillery drills, with "less seamanship and gunnery," as the essayist recommends, would undoubtedly develop the physical powers of the apprentices; there is no question about that. But at the end of the year they would go on board the training-ship, not with "disgust," but with positive loathing. Now there is nothing that can be done for the apprentice in barracks that cannot be done much better on board a properly fitted-up school-ship. There are no better gymnastic exercises than running up and down the rigging of a ship, pulling and hauling on ropes, rowing in boats, etc. Running along with this course of physical training is the ceaseless process, by day and by night, sleeping or awake, of the process of mental absorption, by which the apprentice is taking in, or "hoisting on board," some of the most valuable lessons of the calling of his adoption. His mind is in its plastic state, and he is surrounded by formative influences which mould his character as a seaman. All other considerations are secondary. This species of training cannot begin too early. It furnishes the staying quality by means of which the young seaman is retained in the service when other influences fail. It is the very foundation of his training as a seaman. This invaluable part of the training of the naval apprentice is not only lost while in barracks, but what is much worse, his mode of life there, his habits, thoughts, associations are all diverted into another channel, and one running in a direction diametrically opposite to that into which it is the object of naval training to lead him. And all for what purpose? That he may be under "constant surveillance"! As if that quality inhered to barracks alone, and was foreign to ship life. I make no reference to morals, for the simple reason that the morals of the apprentices can be as well safeguarded on board the school-ship as in barracks, perhaps better. It rests solely with the officers, not on the habitation.

To say that American naval officers cannot conduct the training of naval apprentices on board ship during the first six months of their career, and exercise "constant surveillance" over them, is to confess that, in this respect, they are inferior to the officers of the English and the French navies. I, for one, am not willing to make any such admis-

sion. And yet the radical difference between the methods of educating officers in our service and in foreign services goes far to account for certain other differences. English and French naval officers receive their education on board ship; ours in barracks on shore: they are content to live on board ship; we, as a general rule, are not. In foreign navies there is a premium on sea-service, which includes, in part, duty on board ships on harbor service; with us the fruit falls to those who can stay on shore the longest. A disinclination for sea-service is instilled in our young officers from the very outset of their career; it is made a part of their education. The reverse of this obtains in both the English and the French navy. As a natural consequence, all their training for seamen, boys and others, is conducted afloat. The Navy with them is too serious a matter for trifling. With us everything is done on shore that it is possible to do on shore.

In the last published report of the Board of Visitors to the Naval Academy (June 7th, 1895) it is recommended that the present six years' course be reduced to five years, *all of which shall be spent at the Academy.* In other words, it is recommended to have five years in barracks, to wean the cadets still more from their legitimate profession as sea officers. The present plan has given the Navy two distinct classes of officers, which may be roughly divided into the sea-going and the non-sea-going. There are those who have an innate love for their profession. No amount of barrack-life can alienate them from the sea. There are others again who, having no natural aptitude for the naval profession, gladly lend themselves to the system which cultivates a taste for the shore. The proposition of the Board of Visitors is to cultivate this taste to a still higher degree, and to eradicate, as far as possible, the characteristics of the sea officer.

The law requiring the academic course of naval cadets to be six years is undoubtedly a wise one. Unfortunately the additional two years were put at the wrong end. The two years of sea-service should have preceded the academic course, instead of being made to follow it. By devoting the two first years of the cadets' naval life to the practical parts of their profession afloat, followed by three years of theoretical and scientific studies at the Academy, far better results would undoubtedly be secured. Such a plan, while it would weed out, at the beginning, those who had no aptitude for the naval profession, would conform to the fundamental principle of the science of education, that *the practical should precede the theoretical.* It would, moreover, react favorably on the naval training system, and bring a larger proportion of our officers in sympathy with the seaman class of the *personnel.* But notwithstanding the disadvantages attending the practice of educating naval officers on shore, there are numbers of them who are thoroughly devoted to their profession, always ready to go to sea and perfectly willing to live on board ship when their duties call them there. With such officers the training of naval apprentices can be carried on far better on board ship than it possibly can on shore, and with far better results.

I cannot agree with the essayist in his views in regard to a practice-ship. *A practice-ship should have no steam.*

The Board of Visitors, whose report has just been quoted from, says, "It is essential that every line officer of the Navy should be an accomplished seaman." Hence, as part of the equipment of the Naval Academy, "two lightly sparred, fast sailing sloops-of-war, which should be full-rigged ships," are recommended. The Superintendent of the Naval Academy makes a similar recommendation. He asks for "sailing vessels with no steam on board," and in his letter of January 22nd, 1896, he urges his plea in such a clear and forcible manner that I cannot do better than commend it to the consideration of the essayist. "Seamanship," he justly observes, "cannot be taught on board of steam practice vessels or unwieldy converted steamers." He is right. If a sailing-ship is essential for the proper training of young sea officers, how much more essential is it for the proper training of young seamen?

A word as to training-ships. The naval apprentice should begin his career on board a properly fitted-up school-ship, the ship being for harbor service only. We have never had such a school-ship. The old line-of-battle ship New Hampshire was the nearest approach to one; but she was wanting in proper sanitary and other arrangements, which the Government would not furnish. The law which prohibits repairs on wooden ships when the estimated cost exceeds ten per cent. of the cost of a new ship, operated to prevent the expenditure of money on the New Hampshire. The Bureau of Construction having no interest in the apprentice system, begrudged every penny spent upon her. That Bureau would not even furnish her with boat-davits, so that she had no means of hoisting her own boats; hauling the ship in and mooring her to a wharf was, in a great measure, a necessity. Here she formed a cess-pool for herself, sickness broke out, a board was ordered to examine *and condemn her*, and the ship was sent to New London; the boys, in the meanwhile, having been sent on shore, where they lived in tents. That was in 1889. The apprentices at the station have been on shore ever since. There was no effort made to fumigate the ship or put her in proper sanitary condition. At a moderate expense she could have been made an ideal school-ship, but all appeals were in vain; the Government was determined to get rid of her, and she is now doing duty as the drill-ship of the New York Naval Reserves.*

From the school-ship the boys should be sent to the cruising practice-ship. This, as already stated, should be a sailing ship. The Portsmouth, Saratoga, and Jamestown were model practice-ships. Neither the English nor the French navy could produce their equals, but they too have been given away. The Constitution made an excellent practice-ship, and was so employed for a time; but she was given up. It has been the policy to get rid of all the vessels that could be made useful for training purposes. The Government has given away, or otherwise disposed of, about 12 ships of various classes, some of which would have been invaluable to the training service. The last ship to be disposed of is the Pensacola. At a moderate expense she could have been converted

*It was commonly reported that the New Hampshire was too unhealthy for the naval apprentices. Just how unhealthy the ship is may be seen by the double-page illustration in *Yachting*, Vol. II, No. 21, May, 1896.

into an admirable school-ship for the training station just established at San Francisco.*

From this brief sketch the essayist will see that the newly recruited apprentice boys were put on shore at Coaster's Harbor Island, not from choice, but because the school-ship was taken away from them and they *had* to go on shore; *secondly*, that no school-ship has ever been properly fitted up for their accommodation; and, *thirdly*, that the very perfection of training-ships, the Saratoga, Portsmouth, and Jamestown, were given away.

The Alliance and Essex are no doubt very poor apologies for training-ships, but he should be thankful they are no worse.

Lieutenant W. WINDER, U. S. N.—To be in thorough accord with Mr. Tisdale one must be a believer in the apprentice system. This, I candidly confess, I am not. Since, however, there seems every likelihood that an apprentice system in some form will persist, anything tending to increase its efficiency should be welcomed, and it seems to me that the essayist has offered some valuable suggestions touching this matter.

In particular I am impressed by what is said concerning new and properly designed vessels for training purposes. The necessity of such vessels must be obvious. The discomforts incident to the present training-ships, many of which, as Mr. Tisdale points out, may be remedied by modern construction and appliances, are manifestly not calculated to inspire much love for the service. And this is especially true with regard to boys, some of whom have recently left good homes, and all of whom have been made reasonably comfortable at Newport during a considerable period preceding their first experience of shipboard.

It is not to be expected that any vessel can have "all the comforts of home," but as the comfort of existence advances on shore, improvements at sea, while perhaps not keeping abreast, must at least keep within hailing distance if we are to retain the services of such men and boys as we desire in the Navy.

I entirely agree with the writer when he says, "The training squadron is no place for incorrigible boys, of whom parents or guardians wish to rid themselves"; and again, in the same paragraph, "Then there is a great deal too much of this business of stepfathers and stepmothers forcing their boys to enlist in the Navy." As a recruiting officer I have had some experience in this matter; but unhappily there seems no certain way of preventing this evil, as the boys invariably state, as required by regulation, that their enlistment is voluntary.

The force of the writer's remarks concerning the modern seaman, and the points in which he should differ from the old-time sailor, must, I should think, be apparent to every one. In these times we have no use for men who are "very dependent" and require "always to be looked after." This class has remained with us too long. It is dying out, but it still leavens the mass of the personnel to an embarrassing degree.

On page 281, under the head of Batteries, it is remarked that "The idea

*Since the above was written it has been currently reported that the Pensacola is to be fitted up as a school-ship for San Francisco Bay. It is to be hoped this report is true.

is to have a battery as diversified as possible to give room for instruction. The latest type of modern small arms should also be provided for instruction, though for drill, older types might be used for economy."

To any one who has endeavored to instruct recruits on a receiving-ship having at his disposal an obsolete battery, or (as in the case of the Wabash) no battery at all, and small arms which would bring a smile of derision to the face of a Chinaman, this suggestion will call up emotions which might properly pertain to a dream of the millennium. I earnestly hope that should the essayist's views ever materialize, this point will not be overlooked.

Having during my entire service noted the increased pleasure and contentment which a band offers to the men on board ship, I most heartily concur with Mr. Tisdale's remarks on this subject (see page 289, "Amusements and Non-Professional Instruction"). This is a matter which is by some looked upon as worthy of little consideration, and in view of the more serious matters which engross the attention of officers, it may appear frivolous; yet I believe this to be an error. I have always been impressed with the advice given in a standard work on seamanship, to the executive officer, in which, among other things, he is urged to obtain the services of "a good fiddler." I have too often seen the pleasure which, during leisure hours, the crew received from music, to feel that the question is to be treated with contempt.

Bands will, I presume, continue to be attached to flagships. At present they are, as every one knows, composed of men most of whom it would be irony to style combatants. It therefore happens that the band has many enemies, especially among the first lieutenants, who feel that it takes the place of more useful men. By encouraging, without unduly interfering with their more important duties, a musical training among such apprentices as show aptitude, a class of naval musicians might be established who could on occasion take their places at the guns, or in the company, side by side with the best in the ship.

I am forced to dissent from the writer in several particulars. In the second paragraph, on page 266, he refers to the fact that after leaving the training-ship the apprentices receive too little special instruction and care. I think he falls into the error, which appears to be somewhat prevalent, of confounding a cruising-ship with a school-ship.

In my opinion, the ideal cruising-ship should be the *finished ship* in all respects. As our ancestors put it, she should be ready "to encounter an enemy or weather a lee shore." Drill and exercise will always be essential, no matter how excellent the organization or efficient the personnel. But as a millionaire once said to me, "I have to work, not to make more, but to keep what I have got." And I think this idea should apply to the internal exercises of a cruising ship-of-war. Many officers seem to look upon drill as *an end*, instead of a *means to an end*. I believe that business principles demand from the officers of cruising vessels about all the attention they can give to the *current* working of the system of which they form part. And I look upon it as a useless hardship for them to be required to devote extra work to a class which

is of little present value, and which will, as Mr. Tisdale shows, almost entirely dissipate instead of rendering useful future service. Let officers rather give this time to their divisions as a whole, so that as far as possible their ship may be ready in all respects *to-day*.

If this be done faithfully, *to-morrow* will surely take care of itself.

I must disagree with Mr. Tisdale when he says "There is too much of that wide gulf existing between the enlisted men and the officers," and I fail to see how he reconciles this view with that expressed on page 286, viz., "An officer must not have too much contact with the enlisted men, a little aloofness is better." It is true that these statements do not contradict each other directly in terms, but it seems to me they do so in spirit. That a mutual sympathy and respect should exist between the men and their officers I presume no one will deny. But the experience of ages has established a gulf between them, and this seems to be required by the necessities of discipline.

I must differ from the writer's views concerning promotion from the ranks. A system contemplating such promotion is, in my opinion, less dangerous under monarchical institutions than under democratic institutions, on the general principle that the less secure the position the more tenacious must be the prerogative.

Socialism, now rampant on shore, will, it is to be feared, sooner or later affect military organizations. Indeed there are not wanting indications that the infection has already begun.* Should socialistic ideas unhappily obtain a firm foothold in the naval service, a state of affairs must ensue compared with which a pestilence would be a positive benediction. We cannot, therefore, be too wary lest in adopting seemingly innocent and benign doctrines of democratic civil life, we receive the thin edge of a wedge which ultimately may work incalculable damage to naval discipline.

There are to-day, and doubtless always will be, many persons in the enlisted force of the Navy entirely worthy of bearing commissions. But I hold that to reward individual merit in this manner, however just its claims, would be inadvisable as, by fostering democratic notions in an organization whose internal relations can never be democratic and live, it would seem to threaten those barriers which from time immemorial have been deemed indispensable to military government.

Finally, I wish to express my appreciation of the sentiment conveyed in the concluding paragraph of the essay. In this I am sure I will be joined by all readers of Mr. Tisdale's interesting paper.

Lieutenant A. F. FECHTELER, U. S. N.—I heartily endorse the general scheme of training apprentices as set forth in Mr. Tisdale's essay. Also his ideas regarding inducements to remain in the service.

In one place "irons" are mentioned as a mode of punishment. Of course the boys should not be "coddled," but when one of them needs irons, it should be followed by his prompt discharge.

* Since writing the above, events have occurred in the Navy which singularly corroborate this view.—W. W.

I do not believe in having junior officers on the training-ship. It will soon be impracticable to spare so many line officers for that purpose, but apart from this, it is not desirable.

The instruction and drilling of the boys should be chiefly in the hands of warrant and petty officers—picked men. By all means give the apprentice a chance for a commission, as suggested in the essay. These commissions, however, will necessarily be very few, while warrants and appointments will be many. Show the apprentice at the very beginning what is within comparatively easy reach by putting him in touch with the finest graduates of the apprentice system to be found in the service.

This matter of the *personnel* of the training stations and ships has not been sufficiently emphasized in the essay. It seems to me all-important.

No matter what material advantages in the shape of food, clothing and pay are in sight, boys will not remain in the service and become such men as we want, unless they love and respect it.

I have served on board a training-ship, with the boatswain's mate of one gangway a good seaman, but confirmed drunkard; and the mate of the other gangway sober, but no seaman. Comment upon such a state of affairs is of course unnecessary.

Every person, whether officer or enlisted man, connected with the training of naval apprentices should be selected on account of his fitness for that particular duty. I firmly believe that more good boys are lost to the service by falling into the wrong hands at the start than for any other reason.

The essayist well says, "If there is no ambition in a man, what can we expect of him?" Whatever spirit, ambition, or love of the service the naval apprentice may have, must be obtained from his first instructions. Rules and regulations are very well in their way, but it is their enforcement that counts.

We can afford to have one, or even several, men-of-war lacking in efficiency; but to have an efficient apprentice system it is absolutely necessary to have the training-stations and training-ships models in every respect.

Officers on the Pacific Station feel most keenly the necessity for good petty officers, and hence their interest in the success of the apprentice system.

Lieutenant W. B. FLETCHER, U. S. N.—Ensign Tisdale's article is excellent and thorough.

In the training-ships proposed, why have steam, electricity or torpedoes?

Quoting from page 281: "Admiral Luce says referring to the sailing ship. . . . Indeed it is well known that such an experience (in sailing ships) does affect character and has endowed the sailor with those high qualities of self-reliance, endurance, courage, and patience under difficulties, which have always characterized him." Therefore, why attempt more in the training-ship than the production of the "sailor," leaving torpedoes and electricity for the cruising vessel? Keep the apprentice ten months in the training-ship, as suggested—the time at present is too

short—and aim at thoroughness in what is undertaken, without undue haste; quality rather than quantity; skill with the marlinspike; plenty of time to overhaul clothing; and habits of neatness thoroughly inculcated. In lieu of something better, why not take the engines and boilers out of the Essex and Alliance, save an auxiliary boiler? Give them a flush spar deck and ship rig, and with a flush berth-deck they would then each accommodate one hundred more apprentices with comfort.

The division officers need assistants to help with the instruction. I hardly think it so necessary that each officer take one branch of the instruction. Longer periods of instruction as proposed are needed, and would result from keeping the apprentices on board longer.

Instead of making one long and one short cruise, I would suggest two cruises a year of equal length; one half of the apprentices to be transferred at the end of each cruise; the other half being available to fit the ship out, and being familiar with ship-life, would lead the green ones into their places. At present, on taking 108 green apprentices on board, a month is necessary for them to find out where they are.

Lieutenant W. L. RODGERS, U. S. N.—The paper is so clear a presentation of the present condition and needs of the training service that it is difficult to suggest any additions or to offer any radical criticism of its proposals.

I think, however, that instruction in electricity and torpedoes is too ambitious a programme, and would be content with the present curriculum extended over a year's course. The boys are too much crammed now, and any addition to their studies would be unfortunate even with more time.

The necessity for larger vessels having a covered deck and for reverting to the employment of schoolmasters cannot be too strongly urged, for drills must be carried on in bad weather, and an officer alone cannot give proper attention to the individual instruction of his division of 25 restless boys.

The men who are sent to the training-ships are frequently of an undesirable type in other ways than those mentioned by the paper. For a sober, respectable petty officer without force of character to make the boys respect and obey him is nearly as bad as one who sets a bad example.

Commander F. W. DICKINS, U. S. N. The Board of Control:—I have read Ensign R. D. Tisdale's essay on Naval Apprentices with much interest, and thank you very much for the implied compliment in asking me to criticise his article, which I do not feel that I could do to my full satisfaction without possibly making myself amenable to Article 235, a regulation I have no intention of violating.

I cannot agree with the essayist that the present system of dealing with apprentices should be greatly modified or abandoned. In my opinion, any system, or one that has the approval of an officer of experience, applied to the training of apprentices, either at the Training Station or afloat, if faithfully carried out, avoiding all excuses not to have drills,

but rather to make excuses to have them, will produce good results. Of course, there will be some details in any system which from actual experience suggest some modifications, and, I think, if the writer of the essay would now visit the Training Station and carefully note what is being done here, he would find that some of his ideas and "should-be-dones" are now in full operation.

The system as now organized is persistently and faithfully carried out. It works smoothly and well. The boys are well behaved, discipline well preserved, and desertions practically nil. The results do not warrant the writer's suggestion to "abandon" anything. During the past two years of my command here, quite a large number of our modern men-of-war have been in port, and I have taken the pains to enquire of the commanding officers of the vessels what men occupied the most important petty officers' billets on board, and the answer has invariably been, ex-apprentices. What can be better than that?

I think I agree with the writer that the age of entering should be older, say from 15 to 17 years inclusive. A boy 14 years of age is apt to be very small. A year older would greatly improve his physique and give him more strength to do the work necessary to commence to learn his profession.

The object the Government has in view in enlisting boys to serve as apprentices is to obtain trained seamen to man our war vessels. The Training Station and ships are maintained for that purpose. They are in no sense a training-school to provide admirals nor presidents, commanders-in-chief of the Army and Navy. We have a school for training officers, and the conditions for entering are as democratic as it is possible for a republic to be. The scientific and professional requirements of the up-to-date naval officer are too great to be acquired in a school devoted to training boys for the "man behind the gun," and he should be encouraged to feel that a competent sailor is a valuable man and that he has an honorable profession. His pay, on an average, is superior to his class in civil life. Those of us educated at Annapolis might aspire to be United States Senators, but we were impressed while there with the idea that the career of a naval officer was an honorable one and sufficient for us. So apprentices should be encouraged to know that a chief boatswain's mate or a warranted gunner is a man favored far beyond the average of his class.

The two most important men in time of battle are the one who commands the ship and the one who points the gun, and each should be trained only for the duties required of him at the supreme moment.

Much use is made here, when the weather is favorable, of the training-ship Constellation in handling sails, spars, etc., as the drill is considered a very resourceful one for a boy destined to become a sailor. It draws on his intelligence, nerve, alertness and confidence. This drill, in connection with a recommendation I made while in command of the training-ship Essex:—"That infantry, artillery, pistols, broadswords and gymnastics be omitted in the routine at sea, as they may be better taught in port, and the time given to sails, spars, marlinspike seamanship, lead, log and

compass. In fact, the boys were found to be so well drilled at the Training Station in infantry, broadswords, signals and gymnastics that much of the time now given to those drills on board could be well employed in other instruction," together with my statement: "Training apprentices is very interesting work, and it particularly entails a large amount of work on the executive and watch officers, and of course they should be in full sympathy with their duties. I think they need to be encouraged as much as possible, and, while I think it is their simple duty, I think it would add to the popularity of the training-ship if after finishing a cruise with one lot of boys, the ship remain in port long enough to give each officer a short run, if he desires, before starting off again. I am also of the opinion that long stays at sea in these days of rapid events has, on some officers, a depressing effect; and, I think, there would be more buoyancy in the feelings of all hands if the ship made a port at intervals of not more than fifteen days. These are simply my impressions formed from an experience of one year in command of training-ships, also as watch officer and as an executive officer on board a training-ship,"—do, I think, conform to the pith of the ideas of the essayist. The impression that seems to more or less prevail, that apprentices receive this training in barracks, should be, as far as possible, dispelled, for it is erroneous and wrong.

A boy who enlists at 14 years of age has 7 years to serve. Six months of that time he is here being taught the rudiments of his profession to get him in a proper condition to go on board a training-ship, where he remains another six months, after which he goes into general service to serve the balance of his enlistment. Six months' training on shore out of seven years cannot be called training in barracks.

One year connected with the Training Station, a six months cruise at sea on board a training-ship, being an integral part of it at the proper time and place, is, I think, sufficient training to put a boy into general service, where the fact that the boy is still an apprentice, and will remain one until he is 21 years of age, and that his instruction should continue under less irksome conditions, should not be lost sight of.

I am of the opinion that the rating and pay of instructors should be that of a chief boatswain's mate.

Commander J. F. MERRY, U. S. N.—The essay presented by Mr. Tisdale sets forth in a very practical manner many important facts that should be carefully considered, and I thank him for placing in such a broad light many needs of our training service. If we are to expect any better results from our apprentice system, we must make some changes; but where to begin is the question. One would naturally suppose at the beginning, at the enlistment, and ask, is our present system of recruiting the correct one? Instead of drawing a very large percent of our apprentices from New York City, should we not make an effort to secure men to man our Navy from the sea-coast all along our coast, from Maine to Savannah. Settle on the age best adapted. I would suggest from 15 years old up, and make the term of service five years, no matter what

age at enlistment, say from 15 to 20 years. As a rule our apprentices are too young, and I will venture to suggest that a large percentage of our apprentices leave the service from different causes before they have been one year enlisted. Heretofore young men from 18 to 21 years old could not be enlisted because it has been held that a parent could not bind his son to serve after he is 21 years old, and that a minor cannot bind himself to serve at all; but I believe a recent decision has been made by the Attorney-General that this can be done.

Now that the age is settled, we must have some new training-vessels. I should say that the Alliance class is about the best tonnage. Large vessels are not as well adapted as smaller ones. The yards are too heavy, foot-ropes too long, sails too heavy; then a divided force can better cruise along our coast and recruit the young men who desire to enter; visit all our sea-coast ports once a year; land the battalion, show the people the ships, and explain the advantage of service of the Government. These recruits could be divided, and those over 18 called landsmen, with more pay than their juniors. All should be advanced and detailed to sea-going ships when they develop proficiency. I do not believe in keeping a smart youngster a seaman if he is capable of being a petty officer and no better material at hand. Promote him, encourage him, not let him drag along and see poorer men of less ability advanced just because he is not 21. As soon as enlisted, all should be assigned to some *ship*, and *not* be kept in barracks. It takes some time for a landsman to learn how to live on board ship, and this education should be commenced at once. Some legislation should be adopted whereby a commission could be secured for the enlisted man, but I doubt if it would be best to have him acquire a warrant first. Decide annually upon who is to receive a commission, and then give him the advantage of an advanced course at the Naval Academy or on board a sea-going ship, but make it possible for any man enlisting as an apprentice or seaman to secure a commission, and the standard of our naval seaman will be raised at once.

Recruiting men for the Navy is the most important duty that an officer can be assigned to, care should be taken in selecting such officers, and it should be followed up certainly to the commanding officers of our training-station and training-ships. I think it would add to the efficiency of the enlisted men if some suitable officer was given entire charge of this duty. A Bureau officer has so many duties to attend to, that it would be better to have this duty done by an officer with no other duty. Make his headquarters where you will, not necessarily at Washington. Make it at Newport, but give him entire control of this branch of the service.

I believe with the essayist that the ships with all their equipments and battery should be of modern type; we have had enough of obsolete vessels. A vessel of 700 tons register can be contracted for, for $50 per ton, hull and spars, and at the present time she could be completely fitted for sea for $50,000, outside of her battery. Our old ships soon use up this amount on repairs.

I agree with Ensign Tisdale on the subject of pay. As soon as a man

is enlisted and his pay commences he will look for a larger salary, and the pay should be so graded that every man could receive higher wages every three years, or perhaps for a shorter period of service, whether he is promoted or not. Longevity pay should be adopted, and a service pension should go with it after a certain number of years' service. Men would look forward then for a length of service and feel proud of their service badges. Honorable discharge money should be due the man if he enlist within five years. Often a man secures employment after discharge, and in course of time employment ceases, he has found work on shore a failure, his discharge limit has run out, and he loses the benefit of his past service. Extend the time and many men would re-enter the service that do not.

Ensign Tisdale deserves the thanks of the Institute for his able paper, and I hope it will be read widely, both out and in the service.

Commander C. F. GOODRICH, U. S. N.—There is among naval officers, as there is indeed among the American people at large, a growing disposition to seek in legislation the remedy for their woes. I think we should all combat this tendency and strive to realize that we have no right to apply to Congress for relief until we have exhausted all the means open to us through existing laws. The powers lodged in the hands of the Secretary of the Navy are vast and are only limited by the statutes. For the wise exercise of these powers he must trust to the counsels of his subordinates and advisers, to that general professional public opinion which reaches his ears in a thousand ways, and to such specific recommendations as are evolved through the papers and discussions of the Naval Institute. The latter appear to me an especially valuable instrument for bringing out the views of the service and the arguments of opposing schools of thought on the various subjects which always interest and sometimes vex us. For this reason it seems to be a duty incumbent on officers to express their ideas on such topics in order that, elimination made of minor differences, the substantial voice of the Navy may be heard.

We have devoted some dozen or more years to the development of our material, and have given to the task our best, I had almost said our undivided, energies. Logically this was unavoidable; our crying need was for ships, in the modern sense. Now that we have the ships, the question how best to man them presses upon us and demands answer. The essay of Ensign Tisdale is an attempt to provide that answer by an officer who evidently has the matter keenly at heart and who enjoys the great advantage of a lengthy experience on board a cruising training-ship. He is thus able to speak on many points from personal knowledge. With his views I am, in general, in complete agreement.

Whether or not it would be prudent to hold out a prospective commission as an inducement to enlistment by the would-be apprentice requires serious consideration. Doubtless under the present regime we lose an occasional Nelson, just as we may lose him among the members of the graduating class who fail to win in the competitive final gradua-

tion; but risks must be run, even in time of war, and this is one we can accept with a certain degree of complacency, since Nelsons are not birth-marked and are therefore unrecognizable in time of peace. There being a superabundance of talent produced at Annapolis, I think the burden of proof should rest with him who advocates diminishing the number of vacancies in the service open to the graduates of the Academy.

The warrant of a gunner or boatswain offers, in my judgment, abundant inducement for the very class of men we desire. We want, by the way, to recruit the forecastle and not the admiral's stern gallery. The warrant carries with it responsibility and power, as well as a rank understood and recognized the world over, not to mention a salary which, taken in connection with the social standing and needs of the owner, makes him incomparably the best paid man in the Navy. There is scarcely a lieutenant, for example, who has not to meet great, perfectly proper and matter-of-course service demands upon his purse, from which the warrant officer, with but little less income, is entirely exempt. Where the warrant officer is able to save up and invest, the lieutenant thinks himself lucky if his two ends meet. Figuratively speaking, the one lives in affluence, the other in genteel poverty. The former enjoys a degree of financial success which is beyond the reach of the average citizen. As a substantial reward and inducement, the warrant leaves little to be desired. It only lies with us, his superiors, to utilize the warrant officer on board ship, to make the most of his virtues and training, and to foster a legitimate pride in his calling, to remove the last sound pretext for discontent. To open to this class of officers a possible road to a commission would introduce a baleful and never-ending source of dissatisfaction among them and among the apprentices from whom they are recruited, would hold out a delusive hope to their ambition, and would embitter the nine unsuccessful aspirants while rejoicing but the one more fortunate. The apprentice system was wrecked once before by rendering certain of its graduates eligible to the Naval Academy. I can see no reason for supposing that a different result would attend the granting of commissions to warrant officers, no matter how the process might be guarded or administered. The proposition is fraught with grave consequences. Full and free discussion can alone establish its claims to our acceptance.

I have only touched upon the one point where I differ *toto cælo* from the essayist. In other essentials I am, in the main, in entire accord with him, especially approving the suggested regulations for the enlistment of apprentices, except those relating to the commission.

It is a pity that the training system is not everywhere appreciated as a branch of the service second in importance to no other. It takes the American boy and makes of him an American man-of-warsman. It stamps him forever with its own merits and demerits, and it influences his life till its close. It is a school of patriotism and duty. Surely it deserves just such careful, sympathetic study and such able representation as are shown by Mr. Tisdale in his excellent essay.

Lieutenant C. H. HARLOW, U. S. N.—The advance copy for discussion of Ensign Tisdale's essay on "Naval Apprentices, Inducement, Enlisting, and Training," etc., only reached me on the evening of June 23rd, and as it calls for replies to be in by June 25th, there is too little time to thoroughly enter into a discussion of it, especially in the matter of statistics. A few of these that I have compared with the reports of the Bureau of Navigation are quite at variance with these carefully prepared records as to "acceptances and rejections of candidates," "desertions," and "those that remain permanently in the service." They are so much at variance as to make me sceptical as to the correctness of the other statements, and lead me to believe that if I had the time I might question nearly all the statistical statements that the essayist makes. It is too bad that this should be so. An essay on professional subjects should have been thoroughly tested in details of that kind, particularly as the Department is always ready to furnish any officer who applies for it, all the absolutely correct information on this subject that he may want. I know that figures are notoriously deceptive, and reasonable allowance should perhaps be made, but any statements which differ from those verified by the Department records so materially as those of the essayist cannot pass unchallenged. I feel that no discussion would be complete or sincere unless some attention were paid to this phase of the question, and I have therefore compared certain statements with the reports of the Bureau of Navigation for verification. The results will appear in the regular course of this discussion.

The general question of the training of apprentices for the United States naval service has always been a subject of great interest to me, and after an experience of nearly five years on board of United States cruising training-ships, I claim that I should, at least, have some ideas of the merits and demerits of the present system. Such ideas as I have, however, are radically opposed to those expressed by the essayist, inasmuch as he argues from the premise "that the present system of dealing with apprentices and their disposal after leaving training-ships should be greatly modified or abandoned," while I argue that the present system, *if carried out as provided for in the regulations*, will entirely provide for the faults that the essayist deplores. I shall attempt to logically defend my position by a reference to the text of the essay.

The present so-called *system* of training naval apprentices is the result of experiments extending over a period of twenty years, and embodies the experiences of some of the best officers in the service. It has undergone many changes—from a service entirely afloat to a service almost entirely on shore. It has met with approbation and disapproval from the service at large and from the Department at many times during its career, but step by step, watching carefully the results obtained by the various experiments, there has been produced a series of regulations, a part of the "Regulations for the Government of the Navy, 1893," which still continue in force, and which have possibly undergone fewer changes than perhaps any other subdivision of these "regulations." My contention is, that proper, judicious administration

of these regulations will accomplish all that the essayist or the officers of the service could wish for. I therefore disagree with him in his belief that the present system "should be greatly modified or abandoned," and I will try to follow his essay paragraph by paragraph and show why the present system need not be "*modified*," much less "*abandoned*."

The essayist goes on to say, after making this statement about "modifying" or "abandoning" the system, that "the apprentices are often considered of no particular value on board of general-service ships, and that a good many of the commanding officers consider them a nuisance and bother. They seem to be used principally for messengers and signal-boys." Can this be considered the fault of the apprentices or of the system? Is it not rather the fault of the general service, especially of its commanding and other officers?

Paragraph 866-2 of the Regulations provides that "they shall not be detailed for duty as messengers for a longer period than three months," and if they are not efficient as signal-boys, it is more than likely that these same commanding officers will not continue *that* detail much longer than *three hours*. Now, it follows that if the regulations are carried out the apprentice need not suffer this drawback to his advancement—if learning to carry a message properly must be considered a drawback—for longer than three months. If, however, they prove efficient as signal-boys, and are continued on that duty, they certainly cannot be considered a nuisance and bother, but rather reflect the greatest credit upon one of the most important features of the system. Further, it is now provided that appointments to two of the three petty officer billets open to the apprentice upon re-enlistment, quartermaster 3rd class, and coxswain, are *dependent* upon the candidate's qualifying as a signal-man.

His second paragraph, beginning "After leaving the training-ship it appears that . . . the apprentices receive but little instruction or care, and that they are given at first too many privileges of men," etc., is quite provided for by the Regulations. Art. 867 provides that "the instructions of apprentices shall be continued in general cruising ships, as nearly as possible in conformity with the instruction on cruising training-ships"; and Art. 865-1 says, "On board cruising ships in the general service apprentices shall form a part of the regular complement," while Art. 868 provides for their "proper examination." It is unnecessary to quote the entire article.

In face of these regulations, I ask again, is it the fault of the system, or of the officers of the cruising-ships?

The essayist is quite right in exclaiming against one officer having examined forty apprentices in one day, and in saying that no officer of a training-ship could examine one-half of that number in one branch alone (seamanship and gunnery) in this time.

No officer can *properly* examine one-sixth of forty apprentices in any one branch in any one working day. In the last cruises of the training-ship Portsmouth we allowed each officer the four or five weeks necessarily at sea in returning home from Madeira and the latter part of the

West India cruise, to examine 108 to 140 apprentices in one branch alone; an average of but four a day.

Now as for his objection about their being granted too many privileges of men, it is my sincere conviction that one of the greatest faults, not only of the system of training naval apprentices, but *naval cadets* also, is that they are treated too much as *boys* and not as *men*. It is not the place, and I have not the time, to enlarge upon this perhaps radical view, but the complaint of the service in regard to the boyishness, the lack of manliness of both apprentices and naval cadets, results from this ridiculous conception of their relation to their life's work.

The entire paragraph in regard to whether or not the apprentice suffers by joining a ship that has a small part of its commission to serve, or whether it is better to join a new ship, can, in my opinion, be safely referred to the same query—Is it the fault of the apprentice system or of the officers? It is true that the officer exacts too much of the apprentice, and I am afraid that it always will be so. Again the fault of the officer.

The use of the steam launches can certainly not be laid to the apprentice system. The father of the apprentice system as it practically stands to-day, Admiral Stephen B. Luce, absolutely forbade the presence of steam launches on board of cruising training-ships, and my last three years saw the apprentices manning all the running boats (and there were many of them); they were exercised at oars and sails besides; not as often, perhaps, as I should like to have seen them, but still in a condition, upon our return from a cruise, to pull a good oar, to intelligently take part in the sailing of a boat, and able at any time to respond to a call for such services on board any ship in the service, except perhaps as coxswain of a barge or steam launch, provided that a reasonable allowance be made at the *first call* for their inexperience with the ways of the new ship and their shyness with their new shipmates.

"The study of the system of enlisting and training apprentices in foreign services," etc., *certainly* "furnishes food for thought." While there is a great difference between the people of the United States and those of Europe, it is not necessary to confine ourselves to the compulsory and voluntary aspect of the case. In England, especially, there exists a condition of affairs which is almost without a parallel in this country. They are essentially a maritime people, and there exists an element of society which may properly be said to *breed* seamen. In very many of the densely populated seaport towns there are families, many families, who for generations have provided sons for the merchant and naval marine. There are mothers who beget *seamen*, and the pride of many a household is in their "Jack," serving beneath the red or the white ensign of his country.

I cannot agree with the essayist that "there is an opening for every young man." On the contrary, I believe it is hard now-a-days for an industrious, sober, steadfast and talented young man to get a job, particularly such a job as his industry, sobriety and talent should demand. The United States naval apprentice job calls for just such elements of

character, and attaches "no degradation of social status" in an ordinary or any other sense. No degradation attaches to any one who wears the honored livery of his country, be it a taped shirt or a gold-laced coat.

The balance of the "introductory" part of the essay seems to turn on the social question. There are social grades in all countries and communities. There always have been, and it seems likely there always will be. To my mind the naval apprentice should be taken from that social grade where three warm meals a day, a comfortable bed at night, an assurance of steady employment, and a solvent paymaster constitute the ideal life, *and never above* it. When you pass above this stage you are apt to meet with boys who, unless particularly well balanced, will be likely to suffer by the contrast and become discontented. There is a very broad field, however, covering the social grades *below* my standard, from which you may seek for and obtain sufficient material to fill any and all vacancies that may arise in the apprentice service. Apprentices from these classes are likely to always be better off than those they leave behind them, so far as the comforts of life are concerned, and are certain, as they mature in years, to be more and more contented with their lot.

There is a wide gulf between my grade and that grade of society which is, as a class, generally tainted by crime and viciousness. Should the mistake be made of enlisting an apprentice from this last class, the doctrine of heredity plainly teaches us that the existence of a vicious or mischievous taint in any subject will soon manifest itself, and Arts. 852 and 858 of the Navy Regulations provide for this "weeding out the undesirable boys," both at the station and on the training-ships, so that the general service is relieved of much of the viciousness and, in many cases, of the mischievousness that might otherwise burden it. Let the apprentice come from such grades of society as suggested above, and it is unnecessary—yes, it is wrong—to hold out to him a station in life the requirements of which in a social way he has never had the training for, and probably does not instinctively possess. Much better is it to have him feel that he is assured of a comfortable living and an honorable consideration from his country than to have him constantly regretting that he does not seem likely to become an admiral.

I now come to the essayist's subdivision, "Enlisting Apprentices, and Inducements." His first statement is shocking! to wit: "It must be quite evident that when only ten to fifteen per cent. of the naval apprentices enlisted remain in the service, something is wrong with the system." Quite true, but will he admit that there would be anything so very wrong with the system when twenty-five to thirty per cent. remain permanently in the service, determining to make it their life profession; and when 85 per cent. of the naval apprentices enlisted serve out their period of enlistment and reach the age of 21? To say the least, the Government has been well repaid with the services rendered by these minors, and should be satisfied with the twenty-five to thirty per cent. remaining; but it has in addition the satisfaction of

knowing that those who leave after the expiration of their apprenticeship are on shore, generally near the coast, a trained body of experienced young men; ready at any time to respond to the country's call for men to go on board ship; already familiar with the life, its duties, its pleasures and its hardships; a foundation upon which to build the volunteer system that our Government seems to rely upon so strongly for its national defense.

As I have said, the other statistical paragraphs I have not been able to carefully look over; the above, however, have been verified.

Now, as regards that paragraph which says "not sufficient attention is paid to good character and moral qualifications," etc., I have to state that the report of the Chief of the Bureau of Navigation furnishes me further with the fact that in 1892, of 2290 apprentices who were examined, only 830 were accepted; in 1893, of 1650 examined, only 646 accepted; in 1894, of 1862 examined, only 561 accepted; and in 1895, of 1920 examined, only 348 accepted, a total of 30 per cent. of acceptances from those examined, and these entirely exclusive of doubtless hundreds of candidates who have been rejected from their general appearance, not upon the records as examined candidates, boys so manifestly vicious, deformed or otherwise undesirable as to permit the recruiting officer to pronounce prompt judgment.

If I am wrong in inferring that the essayist has any suspicion of *could* when he says *would* in his statement, "With a reorganization of the seaman branch . . . such that a larger number of men *would* obtain continuous-service certificates . . ." there would have been no need of looking into the matter of C. S. C's. But feeling intuitively that such an idea lay behind his words, I looked up some points and can only ask what could be more liberal than the present law? The number of the C. S. C's is limited only by the number of enlisted men allowed in the service. Every man re-enlisting within three months, with a recommendation for such re-enlistment, is entitled, and all apprentices re-enlisting within three months of their reaching the age of 21 are entitled to a C. S. C. upon application. Preference is always given to the ex-apprentice when considering the applications for the "permanent appointment" and for instruction in the gunnery class, while the warrants of gunner and boatswain are, by law, preferably given to candidates from among the ex-apprentices.

My time is too limited to expand upon the thoughts which every sentence almost of this essay suggests to me in criticism. Either I must be decidedly a crank on the subject, or else during the last year the condition of things on board the training-ships must have very materially changed. This is said without anything more than a reference to the fact that the essayist seems not to have as thoroughly weighed his statements as he ought to have done in preparing an article for the U. S. Naval Institute Proceedings.

He suggests that "inducements and regulations for enlisting somewhat similar to the following be adopted." These suggestions are numbered from 1 to 12 inclusive. Now I find that No. 1 differs materially from

Arts. 836 and 841 of the Naval Regulations only in that the regulations call for the age limit of 14 to 17, while the essayist suggests 15 to 17. I honestly think the change is in favor of the essayist.

No. 2 is already provided for in the Supplement to the Revised Statutes of the United States, Vol. I., 1874-1891, p. 263, Secs. 1420 and 1624, as well as by the Navy Regulations.

It seems to me that so far as No. 3 is concerned, any boy who says he is between 15 and 17 years of age, but who is less than 5 feet high and weighs less than 100 pounds, is so likely to attract attention as to be at once classed with those candidates who fall beneath the personal judgment of the recruiting officer.

Nos. 4 and 5 are especially provided for in every particular by Art. 841, par. 3, Navy Regulations, as well as by the Revised Statutes.

Nos. 6 and 7 I quite agree with, but Nos. 8, 9, 10 and 11 seem to me too absurd to be worth an extended criticism. If naval cadets, after the four years of careful, progressive training in the elements and elegancies of the naval profession, fail to pass that examination which it is necessary to pass to become graduates of the Naval Academy, can it be thought possible for an instant that a young man entering the apprentice service at 17, and after spending four years in the performance of his duty as a naval apprentice, with little, if any, opportunity to study—can it be thought possible, I repeat, that one could be found who might "undergo the same examination as the graduating class of naval cadets"?

Laying aside the consideration of the purely technical studies which are required at the Naval Academy, the standard for graduation in most subjects, except the classics, is on a par with, if not above, the standard of any educational institution in this country.

Presuming that a young man leaves college at 17—the upper limit at which he could become a naval apprentice—his four years of apprenticeship would have to be devoted not only to retaining what he has already learned, but in acquiring that thorough knowledge of the naval professional studies which makes the course at the Naval Academy so remarkably good.

No. 12 I quite agree with. It fits in my platform. If everything else had been done as prescribed by law, probably neither this article nor its criticism would have appeared.

I cannot but admire the departure of the essayist from his ordinary path as he begins his subdivision, "Training of Apprentices." It is excellent, full of thought, and, to my mind, beyond criticism. He is right about the importance of providing the newly enlisted apprentice with a well-fitting outfit of clothing. Many a sensitive boy has had his ardor dampened, if not his intention to desert then and there formed, by reason of the jeers of his comrades when he appeared in a jumper reaching nearly to his knees, with sleeves turned back two or three times, and trousers resembling a pair of flour-bags open and turned up at the bottom. The essayist is also right when he says, "The matter of always being strictly in uniform should be a strong point in the train-

ing of apprentices." My experience has been that it always *was* a strong point. I speak positively in regard to the last ship in which I served, and I challenge the broad statement which he makes, that "they are found right on the training-ship," unless times have changed.

The regulations for the ship's tailor on board the training-ship Portsmouth required that every article of clothing made by him for men or apprentices should be first submitted to the divisional officer, and each divisional officer must critically examine each piece, and with a foot-rule verify the top of the crown of the hat, the width of the band, the width of cuffs, and in fact strictly apply all the requirements provided for in the clothing regulations of the service.

I recall a complaint made by the commanding officer of a cruising-ship that an apprentice from the Portsmouth had come on board with a highly non-regulation suit of clothing. I was a member of the board appointed to look into the matter, and we learned that not an apprentice in the draft had left the ship in any other than the regulation clothing, nor had the last bag inspection revealed the possession of any non-regulation garments among any of the apprentices. But we also learned that the accused apprentice had had a fancy crow-footed suit, with a starred and many-colored cap, made by the ship's tailor, with which to dazzle the eyes of his parents and friends while enjoying his furlough, and had appeared on board the said cruising-ship with his suit, possibly encouraged to do so by the existence of non-regulation clothing, especially caps, among the enlisted men with whom he was thrown. This led on board the training-ship to the issuance of an order forbidding the tailor to make at any time, for anybody, any article of non-regulation clothing, on penalty of losing his job on board that ship.

No; it is on the cruising-ship and not on the training-ship that the charge of not being "strictly in uniform" applies. It can almost be said that at the naval training-station there is absolute ignorance on the part of the apprentices of anything but strictly regulation clothing. Were his experience afloat and abroad of the same kind, the temptation for ti-ties, crow's feet and stars, would never be presented

I do not think that the present system as employed at the Naval Training Station at Newport, under the existing circumstances, can be much improved upon. It is certainly the intention, if not the practice, of the Department that apprentices should remain at the station fully six months before being drafted to the training cruising-ships. This is so nearly the case that it is perhaps well to simply explain to what degree it fails to be exactly the case. A division consisting of 108 apprentices exists on the books of the training-station for six months, taking this date, I understand, from the departure of the Alliance and Essex on their respective cruises, they breaking joints, as it were, as nearly as possible. When the division of 108 apprentices is complete, no more are enlisted for that division, but a new division of 108 is started, so that most of the division of 108 are at the Training Station fully six months, only those who chanced to be enlisted among the eighties, nineties or one hundreds being at the station less than six months. Some may be there longer.

The recommendation for the two sailing brigs is a most excellent one —a much to be desired one. As he alludes, no one who has lain at anchor in the harbor of Plymouth, England, and seen the little brigs sailing in and out each day, having the possibilities of training in every requirement of the deep-water cruising-ship, except perhaps sea-sickness, can but feel and appreciate their great value for training purposes. It has always been a source of wonder to me that in the many appeals to Congress which the advocates of the training system have made, there has not appeared and been fought to a finish the building of two such brigs.

And now, passing on to the subject of the essayist's subdivision of "Training Ships," I would only say that I think torpedoes and the study of electricity might better be reserved for more mature years. There should be electricity for lighting purposes, for health and convenience, and especially for signal instruction and exercise, but I should do no more than leave the dynamo-rooms open at certain times for the inspection of those apprentices who from motives of curiosity, inspired possibly by an inherent taste for these mysteries, might desire to at least ask questions.

The idea of two specially-built ships is of course a very good one, but the essayist has not been emphatic enough in insisting upon a covered deck. *It is an absolute necessity*. Failing, however, to secure any special appropriation for these training-ships, I think that light spar-decks on the Alliance and Essex, with an engine-room bulkhead that can be taken down when not steaming, and hatches to cover the engine-room hatch, would answer the purpose for some time to come. They seriously fail of their purpose as they are now, with open spar-decks.

As to the battery, I can see no necessity for two 6-inch R. F. guns, for more than two 4-inch R. F., two 6-pounder R. F. guns, and so on. I should certainly have 3-pounders and 1-pounders, revolving cannon, field 6-pounders, a Gatling, Maxim, Nordenfelt, and in fact a specimen of every known arm, large or small, in use or suggested for use in the service. I say two 4-inch R. F., etc., that both the Driggs-Schroeder and the Hotchkiss types may be included. The gun-deck should not be regarded entirely as a battery-deck, but a model deck as well, a lecture-room, and so far as possible, photographs and models of armor plate, models of projectiles, powder-bags, all kinds of powder, smokeless and otherwise, and in fact every detail of the ordnance profession should be at hand for inspection and use as an object-lesson to the apprentices. Target practice might be so arranged that an apprentice should fire at least one shot from each of the calibers below 4-inch, and those apprentices making the best records with these guns might be put to the 5-inch and 6-inch guns, to further refine the competition. With a view to the great importance of target practice I should have the 6-inch R. F. on the spar-deck and the 4-inch and 5-inch permanently mounted in the forward and aft ports of the gun-decks respectively, for purposes of daily drill. All other guns should be so mounted that they could be shifted to the spar-deck during target practice, and permit, also, of drill exercises.

It is a great pleasure to find myself so thoroughly in accord with the essayist in his views in regard to the importance of the *sailing ships*, but a pity that I fall to carping at once because he does not let himself loose on it. It is an all-inspiring theme, an all-important one to his subject, and I regret that my limited time compels me to talk quick, but I can't let the subject pass without recording the fact that I view its importance as second to none other in our naval profession both now and in all time to come.

It is my sincere belief that square-yard and sail training is the corner-stone and cap-stone of the seaman and officer as much to-day as in the times of John Paul Jones or the studding-sail-boom hero of Cooper's novel. It is the all-in-all, the without which neither officer nor man has any more right to the title of his profession than has a doctor who has never visited a hospital to hang out his sign and aspire to practice. To depart in the slightest degree from the utmost practice of seamanship aloft and on the bridge, as the foundation of a line officer's education and training, is to hazard his unquestioned claim to command; to withhold a single chance from the naval apprentice handicaps his value as a helmsman or a gunner, deprives him of that development which will carry him with firm-set nerves right up to and through the dreadful crisis of the ram or the torpedo.

Away with your sails, if you please, strip your masts of their yards, but after you have done so, produce me a man to compare in fertility of resource, in keen judgment, in fearlessness, in dash, in courage, in leadership, in all that makes a manly man, with the one who has been trained at the weather-earring or in smothering the mad billows of a thrashing sail! You can't do it.

There is a something about the sailing-ship sailor which marks him from his mates of the shovel and oil-can on board ship, a something that shows itself at the gun, about the decks, on shore; a manliness, an independence, a something that catches your eye when looking for volunteers, a something that responds when you call for them. Few men are naturally fearless, still fewer born with a ready wit to meet emergencies as they arise. There is but one school to properly teach those who follow the sea in their country's service, and that is the school of the top and the cross-tree, the surging yard and the bellying canvas. It is calisthenics and morals combined, and far be the day when sails, yards and masts cease to be the main features in the primary training of the naval apprentices.

As a school for the young officer, too, nothing can ever give him that habit of observation, that attention to detail, that self-reliance, that readiness to meet the calls of the minute that are the constant companions of the officer-of-the-watch on a sailing ship. No better school for learning the strength and weakness of men as a class, for studying and appreciating character, for getting "work out of men," as the saying is, than on the deck of a sailing ship, and the essayist does well to call attention to the importance of the sailing ship for both officer and man. The two training brigs suggested would be a most excellent school. With

a lieutenant in command, and a detail of young officers to fill the duties of executive and navigator, as well as watch officers, short cruises of a few days might be made to the great advantage of the officers and apprentices. A ship's cook and a seaman in each part of the ship would be all of the experienced force needed forward, and an interested set of officers aft would soon develop the boys and bid fair to keep alive that class of men made glorious in history by their records of pluck and daring.

There is much that my limited time prevents my passing upon, either critically or otherwise, but I cannot pass the suggestions in regard to "amusements and non-professional instruction" without expressing my belief that it has perhaps as much to do with inducing apprentices to remain in the service as any other attraction, not excepting pay, that can be offered. The last three commanding officers of the Portsmouth were believers in this idea, and encouraged singing, magic-lantern exhibitions, horizontal bars, Indian clubs, dumb bells, and boxing gloves, and as a part of the daily routine, the piping of "all hands to play," whenever the weather permitted, during the evening hours.

A library of light reading, selected with a view to the apprentices almost entirely, was procured by the modest subscription of five cents a month from each officer, man and apprentice who was willing to subscribe, and the appearance of what was left upon the completion of the cruise attested the value which the boys placed upon it. Few, of the several hundred books purchased, were in a condition to be even worth sending to a hospital.

In the matter of food, the custom of commuting a certain number of rations and purchasing articles not covered by the regulation naval ration in addition, resulted in the fact that of over six hundred boys who cruised with me during my last cruise, there were not a dozen who complained at any time of the food, except in cases where some bully in the mess had ruthlessly robbed his weaker messmate of his allowance. This bespoke a contentment on one very important point. Different boys were detailed weekly to take charge of the mess. Their duties required them to set the tables, receive the ration from the ship's cook, distribute it, clean and restore the tables and utensils, and for this they were allowed in cash their 30 cents a day ration; provided, however, that the record of the mess utensils with which they entered upon their duties tallied with that which they turned over to their successors. Inasmuch as they bought their own mess gear, they paid for what was lost.

The suggestion for schoolmasters to accompany every division is unquestionably a good one. There should be a sufficient number of schoolmasters, or boatswain's mates, 1st class, at the training station to provide for at least two for each division of boys, who should be associated with it until it was drafted in the general service, and who should then be re-attached to a new division at the training station.

In regard to a permanent crew for the training-ship, the essayist emphasizes the matter of having men of good habits selected, and every-

thing should be done to encourage good men to remain on the training-ships. The commanding officer should further have the assurance that at the end of the training cruise any recommendation that he should make to the Bureau to that end should be immediately complied with, as it would be better to err on the side of perhaps removing a man who was only at fault in his example, by accident, than to have a new draft subjected to the possibility of being the witnesses of another accident. The force of example among boys of that age is very great, and the essayist thoroughly appreciates it.

I can only state in conclusion that the essayist has done a good thing for the service in opening the door for the discussion of this, to my mind, important feature of the naval establishment. I have not agreed with him in many particulars, nor do I expect that others will agree with me, but from all the discussions (and I trust they will be very general) there may arise a more catholic spirit towards the training system and its results than exists now. I have never been thrown with a more conscientious set of officers as regards the duty that was put upon them than in the training service, and I must say that I feel that most of the criticism which the training system has been subjected to has resulted from the failure on the part of the officers with whom apprentices were thrown after leaving the training-ship, from not knowing the regulations covering them, or else, knowing them, failing to properly administer them.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ELECTRICITY IN NAVAL LIFE.

By LIEUTENANT B. A. FISKE, U. S. N.

$750,000,000 is the amount stated by *The Electrical Engineer*, after a careful investigation, to be the capital invested in the United States in the various electrical arts, such as the electric light, telegraph, telephone, electric railway, etc., etc. In examining the causes for the investing of so large a sum, we must conclude that either the people in the United States are a very unwise and visionary class, or else that electric appliances do really possess some qualities which contribute to their comfort and happiness in a practical way.

In examining the results of the use of electricity in naval life, we must admit that, up to the present time, electricity has fulfilled all the promises it has given us. It has made our ships brighter, cleaner and healthier; it has lightened the task of enforcing discipline; it has increased the accuracy of gunnery; it has made instruction interesting; it has assisted the surgeon in diagnosing wounds and relieving pain; it has given the captain better control of his ship, and the admiral better control of his fleet; it has added an element of intelligent interest and expectation to each new addition to our Navy, and it has brought into active sympathy with the sea-going class a large and influential body of progressive men on shore.

The enormous development of the use of electrical appliances in all countries of the civilized world, and the beneficent effects resulting, are bearing practical fruit in naval life. The experience gained by electric railway companies, electric light companies, telephone companies, telegraph companies, and all the other thousand and one branches of business in which electricity

is used, has proved that electrical apparatus may be relied upon provided two conditions are fulfilled. The first condition is that the electrical apparatus shall be designed to meet the particular circumstances of each case; the second is that it shall be cared for by men who understand it. The increasing confidence shown in it by naval authorities has been particularly evident in France, where numbers of ships have been constructed in which electric power is used to do almost all the work heretofore done by auxiliary steam engines.

The principal difficulty that electricity has had to meet in our Navy has been the fact that there has been very little incentive for officers and men to study it; so that most of those who have become proficient (enlisted men as well as officers) have gone into civil life, and we find them distributed among the various colleges and electrical enterprises of the land. There they are doing good work for the country and are making honorable reputations for themselves, but, so far as helping the Navy goes, their services are lost. So it is not surprising that electrical apparatus has come into use in the Navy so much more slowly than it has come into use in civil life; but it is surprising that it has come into use so rapidly as it has, and exhibits a more progressive spirit than seamen are usually credited with possessing.

It is frequently stated that the reason for the slow progress of electricity in naval matters is the difficulty of meeting the conditions of ship life; but this position is hardly tenable, because the conditions for the use of the electric light, electric motors and telephones in war-ships are in reality not nearly so severe as they are in hundreds of positions along the coasts of the country and through the long stretches of the mountainous and comparatively unpeopled sections of our western lands. In reality there can hardly be found, outside of the college laboratory, conditions which are in many respects so favorable as those to be met on board a modern war-ship. In the first place, the distances through which the electric current are to be transmitted are extremely short; in the second place, the item of expense does not control to so great a degree as it does in the operations of commercial life; in the third place, in case of any accident or derangement, the place where this accident or derangement occurs is always within a few feet of somebody, so that it will not have to be hunted for, as frequently happens

with apparatus on shore, through miles of country; in the fourth place, the solidity of the structure of a ship and the excellence of all of the mechanical appliances are in great contrast with the flimsiness of the structure and the cheap character of the installation which have, for financial reasons, in many cases to be made on shore.

About ten years ago the writer had occasion to deliver a lecture before the Franklin Institute, on Electricity in Warfare, and about four years later, another on the same subject. In the first lecture the operations of electricity in warfare were almost wholly hypothetical and promissory. In other words, the effort of the lecturer was to point out what electricity might be made to do, perhaps. In the second lecture he was able to state with some positiveness that some things could be done and, in fact, that some things had been done. In the present paper he takes pleasure in stating that certain things have actually passed official tests in sea service, and he will confine himself to facts without indulging in any flights of the imagination. To emphasize the difference between the state of affairs obtaining now and the state of affairs obtaining at the time of the first lecture, it may be said that at this first lecture there were present a commodore and a captain of the United States Navy, both officers of high ability and character, and, in a conversation after the lecture, they pointed out the impossibility of using the electric light on board ship by reason of the impracticability of getting sufficient space for the dynamo. In spite, however, of the successful efforts of the Genius of Electricity in ameliorating the conditions of shipboard life, there are still many objectors, and it is a fact that a contest is going on between electro-mechanical and other mechanical apparatus in very many of the important operations in ships and forts, which promises to be as lasting and as bitter as the contest between steam and sails; and yet it is easy to one who watches the drift of modern engineering practice to see with which the ultimate victory will reside. Just now the fight is going merrily on, and the public benefits by the competition. No sooner does an electrical device score a success than some ingenious person does the same thing with mechanics; and no sooner does an important mechanical invention accomplish some new thing than an electrician throws it altogether into the shade by a novel use of electricity. It may

be stated as a general law—but with the distinct understanding that it is only general—that mechanical appliances have the advantage of greater simplicity of principle, and that electrical appliances have the advantage of greater simplicity of operation. To paraphrase this statement, mechanical appliances are more easy to understand, but electrical appliances are more easy to use. Mechanical appliances require less instruction for their use; electrical appliances render available a higher grade of intelligence and also require a higher grade of intelligence. Electrical appliances strive for an idea; mechanical appliances do what is required at the moment. The advantages of maturity and experience are on the side of mechanical apparatus; but youth and the promise of the future reside with electricity. Mechanical appliances are less apt to deteriorate from disuse; electrical appliances are less apt to deteriorate from use; mechanical connections are liable to give out under the sudden strain of emergency; electrical appliances, from their nature, suffer little strain in use and are not apt to fail in emergency if found to be in good condition before the emergency occurs. A mechanical connection, if broken or injured, gives plain sign of the whereabouts of the trouble, but the trouble is with difficulty repaired. A trouble in an electrical connection is sometimes hard to find, especially if the apparatus is not thoroughly understood, but when found, is remedied with ease. The difficulty of repairing a break or disarrangement of a mechanical appliance, caused by a stress, is usually in proportion to the greatness of the stress; but with electrical appliances, the cause of trouble is usually minute, and can be repaired as soon as found.

A very important enemy of electrical appliances on shipboard has been the "fatal facility" with which bad electrical apparatus can be installed. It has always been so easy to run a wire or to put in a battery, or a bell, or a dynamo, which would work for a week, that in very many cases it has not worked any longer. Good work on electrical apparatus often seems so unnecessary that slipshod work is substituted, and it does as well as any other for a while; but suddenly the apparatus fails, and then one hears on all sides complaints of the untrustworthiness of electricity. Nevertheless it is a fact that the naval and military uses of electricity are increasing. The same reasons that have filled modern cities with telephones, telegraph, electric motors and

electric lights, are filling our modern war-ships and fortresses with them. The same reasons that gradually replaced the club of the savage with the magazine rifle of the modern soldier are operating to replace the simple but clumsy ships and battery of a few years ago with war-ships of tremendous power but vast complexity. It seems to be a law of nature that we must pay for what we get. If we will have monstrous engines of war, dirigible with precision and rapidity, we must use complex machinery, protest as we may.

There is one very important phase of this question to be considered, and that is, that in this feverish march of progress, one must either keep up or fall behind; and a navy must either keep up or fall behind. This state of affairs becomes more and more acute the farther the march of progress proceeds; and the view may be extended even farther, so that we can see that the more complicated ships and weapons become, and the more education and instruction and drill are needed for their efficient handling, the greater advantage will rest with that navy which devotes to them the needed education, instruction and drill; provided always that the increase of power of offense and defense is sufficient. This statement may be put in another way:—In any apparatus which bestows vastly improved powers of offense or defense, mere complexity is not a disadvantage to any navy which devotes sufficient time and labor to mastering the difficulties, because the very fact of its complication gives that navy great advantage over navies which cannot or do not master the difficulties. This indicates the principal advantage of the civilized soldier over the savage. The civilized soldier is no more brave than the savage, and very often is under the greatest disadvantage by reason of lack of acclimation and of knowledge of the country. But the complicated arms and organization of the civilized forces are too much for the brain of the savage, and he is forced to retreat before the complications of civilization.

This argument is not intended to prove that complexity has of itself advantages over simplicity, because simplicity is the perfection of efficiency, as it is of beauty. It merely points out that the part of wisdom of a highly civilized nation is to develop weapons of the highest possible power, and to educate the officers and men to handle them. An hour every day taken from

the merely routine work which highly educated officers of middle life are compelled to do, would show us that our profession is not only one of the most glorious in the world, but one of the most interesting, and would give us an opportunity of keeping up with the progress of the times.

In describing broadly the uses of electricity in naval life, many uses, not strictly new, must needs be included. The subject may be divided somewhat as follows:

Electric Lighting.—The electric light is now a *sine qua non* in modern war-ships. The principles previously laid down have been proved correct in practice, and the present development is along the lines of an increasing supply of lights and the gradual improvement of the details of wiring and insulation. The number of officers and men acquainted with electrical things has naturally increased, and this has brought about a better functioning of the apparatus used, as a necessary result. Search lights of automatic feed, controllable from a distant point, have proved practicable; considerable diversity of opinion still exists as to whether they should be high above the water or low down, but the advocates of high positions are gaining ground. No important change has taken place in signal lights.

Electrically Operated Steam Whistles.—These have been recently tried in both war-ships and merchant-ships with promising results. They do not interfere with the ordinary method of sounding the whistles, so that their use seems to confer a distinct advantage with no offsetting disadvantages.

Motors.—The use of electric motors is clearly on the increase, especially for ventilating, the training of turrets and the hoisting of ammunition. Perhaps the advantages of electric power over steam are more obvious in the matter of ventilation than in any other field, the principal gain being in the fact that the necessity is avoided for the tremendous air ducts which take up so much room in coal bunkers and living spaces, and the substitution of a number of comparatively small ventilators, each placed where it is wanted, instead of the large steam blowers for which room is so hard to find. The military advantage of the small electric ventilator is one that may easily be overlooked; but it is a well-known fact that in many ships the steam blowers have had to be placed above the water line and absolutely unprotected; which means that in the early part of an action

the blower supplying one or more of the magazines may, and probably will, be put out of operation by a very insignificant cause, making it absolutely impossible for the men to remain in the magazines.

For training guns, the practice of employing motors is becoming limited to turrets, the mechanism being arranged in such a way that hand power can be used in case of accident. As regards the relative advantages of the three principal powers, steam, hydraulic, and electrical, a wide diversity of opinion exists. The great desideratum of simplicity resides, of course, with steam, and many regard this feature as of paramount importance. Others, however, while admitting the superior simplicity of steam, and while admitting the enormous value of simplicity, point out the extreme difficulty of securing a "dead beat" motion with steam, even if a worm and screw be included in the mechanism. They also point out what at first sight may not seem an important point, but which may readily become so—the question of heating; insisting that, no matter what mechanism may be employed, it is after all "the man behind the gun" on whom we must rely, and that the man behind the gun and the men in the passing rooms will not work at their best in an unendurable heat.

The principal advantage of hydraulic engines over steam and pneumatic engines, arising from the incompressible nature of water, is the absolute rigidity with which they hold the turret. If the valves are closed, the turret cannot move; and the turret can never make the water motor go at a greater speed than that for which it is set. In the sighting hood, the continuous turning of a wheel by the operator at any desired speed controls, on the floating lever principle, the speed at which the turret shall go. The muscular effort required is so considerable that he is compelled at frequent intervals to move his eye from the axis of collimation of the telescope, which is almost fatal to fine shooting. Now electrical men show that they can attain fully as much nicety and precision by electric means, using a controlling switch so easy to move that the eye can be kept continuously at the telescope until the instant of fire; and, furthermore, they proceed to point out how pipes burst and valves leak just when called upon to work. In most, if not all of the plans hitherto tried for electrically training turrets, however, control

of the motor's speed has been sought through the putting of more or less resistance in the circuit of the armature. The difficulty of handling large turrets by this means is of course great, and the means thus far employed can hardly be called satisfactory. They do not need describing here, because in fact they are bad and should not be used. In determining why they are bad, let us consider what is needed in order to control the training of a turret in a sea-way. The turret weighs a hundred tons or more, and it is rare that its center of gravity is in the axis of rotation. As the vessel rolls from side to side, the turret tends to move by its weight in one direction or the other, the effect being at a maximum when the guns are pointing ahead or astern. Let it be supposed that the turret is pointing ahead and is stationary, and that the turret captain wishes to train it to point at a target on the starboard beam. He moves his lever to the front and the turret starts to turn slowly, the great mass of the turret preventing its suddenly taking up a rapid motion. Just now the ship begins to roll to port and the turret has to climb up hill, besides being accelerated. As the roll continues, the hill becomes steeper, until it reaches a maximum, and then it becomes less and less steep, until an even keel is reached. This has taken—say, eight seconds, and the turret has just about reached the speed at which it is intended to run, when the ship starts to roll to starboard; the turret now tends to run down hill, and the motor is doing its best to help it. Evidently, the arrangement of the motor must be such that without any conscious effort from the operator, the turret will not be permitted to run down hill, for the mass is so great that the consequence of mental confusion or inattention on the part of the operator might be serious. In other words, the motor must be arranged so that it cannot run above a certain speed. This is usually expressed by saying that we must use a "constant-speed motor."

It has been objected frequently, however, that constant speed is not needed, or even desired; that what is wanted is simply ability to get the turret quickly around to the target, and to move it quickly to the right or the left in order to keep the guns pointing at the target.

Without wishing to detract in any way from the importance of these points, it must be insisted that everything should be

done to make the gun captain's work easy, that his mind should be as free as possible from mental calculating, his lever as easy to move as practicable, and that the movement of the turret should bear a definite relation to the movement of his lever. Let us suppose that this is not done and that the turret's speed depends on other causes than the movement of his lever. Is it not plain that the captain will have to jerk his lever around more frequently and spasmodically than he would if each position of his lever meant a certain speed? If each position of his lever can be made to mean a certain speed, regardless of everything external, is it not plain that with a little practice, and even if the gun captain does not know anything in figures about either the position of his lever or the revolutions of the motor, he will yet insensibly come to feel that he with his own arm is moving the turret, and that his own will controls its speed? Can he not then follow a moving target with far greater precision than would be possible if the turret would spasmodically speed up or down from moment to moment as the ship rolled?

It is not an answer to this to say that it is impossible to get constant speed under the circumstances, that the speed and direction of the turret must frequently be changed, that it will always take a certain interval of time for the heavy mass to make the change, and that during the interval the speed of the turret will be either increasing or decreasing. This objection, while it includes a true statement, is really misleading, because it amounts to saying that, if perfect control of any machine cannot be obtained, we should therefore refrain from attempting to make the control of the machine as perfect as we can. To attempt the control of a turret in a sea-way is like trying to solve a problem containing many variables; and it is axiomatic that the solution of any such problem is easy in proportion to the reductions we can make in the number of variables. Applying this principle, we are forced to the conclusion that the motor for the turret should be so arranged that its speed shall vary as little as possible from the speed set by the gun captain. Now, it is not hard to get a constant-speed motor; but unfortunately for any given electric potential applied to an electric motor, there is only one speed that can be constant; so that, in order to make a motor run at different constant speeds, different potentials must be applied, and each potential must itself remain

constant during the interval of time for which the corresponding speed is desired. In other words, in order that the gun captain in the sighting hood may be able really to command the speed of rotation of the turret, he must be provided with a system by means of which the potential which he applies to the motor shall not change, unless he himself intentionally changes it. Reverting now to the statement made before, that all methods of controlling turret motors are bad in which resistances are varied in the armature circuit, we see at once that it must be bad if the potential applied to the armature terminal is liable to change. That it is liable to change is easily proved, as follows:

If an electric motor is running at any speed, and if its load be suddenly increased by any cause, such as in this case, by an increase in the heel of the ship when the turret is running up hill, the motor tends to slow down; this reduces the counter electromotive force that the motor is generating and therefore increases the current in the armature. Now if a certain resistance (say $\frac{1}{10}$ ohm) has been put in the armature circuit when the armature current was 100 amperes, then, since $E = CR$, the voltage expended in heating this resistance $= 100 \times \frac{1}{10} = 10$ volts, and the voltage of the armature terminals falls from 80 volts to $(80 - 10 =) 70$, so that the motor is running really on a 70 volt circuit. Let now the load be increased so that the current increases to say 200 amperes; the voltage now lost in the resistance $= 200 \times \frac{1}{10} = 20$ volts, so that the motor will run at 60 volts instead of 70 volts. The action, then, of an increased load on the motor has been to decrease the power supplied to it, which is just the reverse of what was wanted.

In endeavoring to meet this trouble, Mr. Ward Leonard devised a system which is in use considerably for working large cranes and elevators. By this system, the speed of a motor is regulated by increasing the potential applied when it is desired to increase the speed, and decreasing the potential when it is desired to decrease the speed. To accomplish this, Mr. Leonard runs an auxiliary motor direct from the electric mains, and this motor has a dynamo of about the same size on its shaft, so that the motor turns the dynamo and makes it generate a current, which current goes to the armature of the motor that does the work. The magnetic field of this working motor is excited direct from the main circuit, and so is the field of the

dynamo which the auxiliary motor turns. But there is a variable resistance placed in the field of the dynamo circuit. Now by putting in more or less of this resistance in the field, the electro-motive force, generated and sent to the working motor, is decreased or increased, and the working motor is governed with astonishing precision. As the current, moreover, in the fields is always small, the great difficulty is avoided which always exists in putting resistance into or out of circuits having heavy currents.

One great objection to this method is the obvious one that two motors and a separate dynamo are required to do one motor's work, and the additional motor and dynamo must each be at least as large as the working motor. In the U. S. S. Brooklyn, two of the turrets are to be turned by electricity and two by steam, the idea being to have an absolutely fair competitive test under service conditions at sea. A novel plan suggested by the writer is to be tried which need not be described here, as it will not be interesting unless it prove successful.

Besides constancy in speed there are two other principal desiderata in the turning of a turret: first, sufficient speed of turning to bring the guns on to a target, and to follow it when its direction is changing, and second, extreme nicety of movement, which means ability to quickly move the guns in one direction or the reverse through small angles, and to stop it quickly when desired.

In deciding upon the speed required, the question resolves itself merely into deciding how much money and space can be provided for the power, because the highest speed attainable is desired. The speed, however, ought to be at least that necessary when two ships 1000 yards distant are passing each other at fifteen knots each, because this situation may nearly occur. Two ships passing each other at this distance and speed change their relative directions per second through an angle the sine of which is

$$\frac{(15 \times .57)\ 2}{(1000)} = \frac{17.1}{1000} = \sin 1^\circ \text{ (approx.)}.$$

This speed is clearly much less than would be required for handling the gun in a sea-way, having regard merely to the uncertain motion of the ship itself. So in our new ships, the speed specified is many times this, even under a considerable heel, when the turret will have to run up hill.

The problem of quickly turning the turret becomes afterwards one for the electrical engineer. He is told that the weight of the turret is so many tons, that the friction is so much, that the center of gravity is so many inches from the center of rotation, and that he must make the turret run at a certain speed. The question is so far one of horse-power. But he must also be told that the motor must be so designed that it will not become stalled (*i. e.* unable to move) under any probable roll, because, when a motor's armature is stationary the current through it is enormous, being ($C = E \div R$) that due to the potential between the mains (in the United States Navy 80 volts) and the ohmic resistance of the armature itself. To guard against an excessive current, in case an extraordinary roll should stall the motor, it is well to put an electro-magnetic cut-out in the armature circuit, which will automatically break the current if it exceeds an amount for which the cut-out is adjusted.

As it would be impracticable to provide sufficient power to maintain constant speed under heavy rolls, it becomes necessary to prescribe that the speed shall be constant up to a roll of say 10°, and permit that it may slow down when the angle of heel is greater, being careful that the speed shall never fall to zero under any probable circumstances.

The question of nicety of train, in the case that abundant power has been provided for the efficient rotation of the turret under ordinary rolls, is largely one of the construction of the switch which the gun captain moves. As the gun captain views the target through his telescope, the vertical and horizontal cross wires appear to be describing irregular curves against the background of the sky. His effort must be to bring these curves into the vicinity of the target. Though the motions of the cross hairs are seemingly erratic, they can, of course, be resolved into two motions, one horizontal and the other vertical. If the advance of the ship was in an absolutely straight line, and if the ship rolled the same amount from side to side and at regular intervals, the curve of the point of intersection of the cross hairs would be regular, and it would be comparatively easy to bring this intersection on to the target. But it is rare that a ship moves exactly in a straight line, in a sea-way, even when steaming on a certain course, for she yaws gently from side to side. Neither does a ship roll regularly. Even under the

best circumstances she rolls a little more to one side than to the other, and the rolls vary in amount from time to time. Then a ship frequently comes to rest for a while on an approximately even keel, and then starts to rolling again. Besides the rolling there is also the pitching, and this complicates the motion of the cross hairs, especially when the guns are pointing on the bow or quarter. The up and down motion is the quickest and the most irregular, so that the real problem is to so move the turret as to get the vertical cross hair on the target at the instant when the rolling throws the horizontal hair across the target, and to press the firing button at that instant, changing the elevation of the gun itself as little and as seldom as possible. With a large field in the telescope the vertical wire shows the direction in which to move the turret, even when the horizontal hair is several degrees above or below the target, so that the success of the gun captain, or rather of the man who is charged with the training of the turret in azimuth, in keeping the vertical hair across the target is dependent on the ease with which his switch can be moved, as well as on the response of the motor to the switch; and it is absolutely essential that the moving of his switch must not in the least disturb the position of his eye at the telescope. For this reason the motion of the switch must be to the front and rear, and not to the right or left.

Steering by Electric Motors.

This has been accomplished in several vessels, the most recent apparatus being in some "whale-backs" on our great lakes. The writer secured three patents some eight years ago on electric steering, but has not as yet had an opportunity to get his system tried. One of the patents covered broadly "the method of controlling electric motors whereby the motor follows the motions of the operator's hand in speed and direction," just as is done by the ordinary steam steering engine and the ordinary ash hoist. In the Brooklyn the experiment will be made of steering by electricity by means of what is called a tele-motor. The apparatus will be installed by Williamson Brothers of Philadelphia, who have made so many of the steam-steering apparatus for our new war-ships and merchant-ships that they may be presumed to understand the requirements of

good steering. There is more doubt, perhaps, about the advisability of using electricity for steering than for any other of the uses to which auxiliary engines are put in ships, because nobody wishes the steering machinery to be otherwise than absolutely reliable, and because steam-steering machinery is now so good that little is left to be desired. Electric steering, therefore, must at present be considered as doubtful, and the burden is on it to prove its value. Meanwhile foreign nations are also experimenting on it; and Messrs. Williamson Brothers do not wish to publish their own plans until they have achieved success.

Electrical Firing of Guns.

When one reflects that a vessel rolls from side to side in about eight seconds on an average, that even under very good circumstances she rolls more than one degree per second, and that with the modern guns an error of ten minutes of arc in the elevation of a gun above the horizontal at the instant it is fired means an error of about 200 yards in the distance the projectile will go, and that in the case of a ship 2500 yards distant this error of ten minutes of arc will throw the projectile about twenty-two feet above or below the point aimed at, we see that it is necessary to fire the gun in such a way that a less time than ten-sixtieths = one-sixth of a second of time will elapse between the time that the gun captain makes up his mind to fire the gun and the time that it is actually fired; unless the gun captain resorts to the method of firing his gun before his cross hairs rest on the target, by an interval of time which he estimates will be such that when the gun is actually fired the cross hairs will actually rest on the target. Of course, this method is often used with great success, and a "born shot" can, with sufficient practice, so use it; in fact, "born shots" do successfully use it, but only "born shots" can, and even they need more practice than is given or can be given in any navy in the world. To place accurate gun firing within the reach of ordinary men, electrical firing is used, in which the captain can fire without taking his eye from his telescope (or sights), and by such a slight pressure of his fingers that he can fire very quickly after making up his mind to fire, and (which is fully as important) without moving his eye from the telescope. Practi-

cal results show more accurate firing with electricity than with either percussion or friction. Complaints are sometimes heard of the untrustworthiness of electrical firing; but if electrical firing apparatus is properly installed, it is more simple and trustworthy than any other means. The real trouble is that as yet there are not enough people on shipboard who understand electrical apparatus. As to the concentration of fire by electricity, it has few friends and they are thinning out rapidly, as the system serves no useful purpose.

The advantages of electrical firing over percussion and friction firing are therefore two-fold. First, the time elapsing between the instant when the gun captain makes up his mind to fire and the instant when the gun actually is fired is very much shortened; second, the gun captain is able to keep his eye on the line of sight until the gun is actually fired, because, since his fingers alone have to act, his head is not jerked to one side, as it is by the physical effort of pulling a lock-string. These advantages are not very evident in the case of firing by the use of the ordinary bar-sight, because the gun captain stands several feet away from it (the bar-sight), and his line of sight is so uncertain that a little more uncertainty does not seem to make much difference. But the whole matter is changed as soon as one comes to look through a telescope sight, because then the line of sight is so absolutely defined that one knows exactly what he is pointing at, and he sees just as soon as he tries to pull a lock-string that by the time he gets the lock-string pulled his telescope sight has been moved by the motion of the ship, so that it no longer points at the same thing at which he pointed when he made up his mind to fire, but points at some other place. A long essay might be written to prove the reasonableness of electric firing, but it would not be half so convincing as a single look through a telescope sight when the ship is rolling, even as slowly as one degree per second. A change of one degree in elevation, let it be remembered, means a change of about 1000 yards in range on the average.

The details of electrical firing have given a good deal of trouble, but they seem pretty well worked out now. It is to be hoped that every "bug" will soon be overcome, because otherwise (since foreign navies are so successful with electrical firing) the U. S. Navy will have to give up its pre-eminent reputation for

fine gunnery. The single wire system is the one adopted in our Navy, in which one end of the fine platinum-iridium fuse wire, which is heated by the firing current, is electrically connected to the metallic body of the primer. As one pole of the firing battery is connected to the metallic carriage holding the gun, and as the metal of the primer is in contact with the gun, the circuit is completed when the gun captain presses his firing button; then the current heats the fuse wire, and the heat communicated to the primer ignites it and fires the charge.

The idea so long mooted and so much tried, of firing an entire broadside by the electric current controlled by the captain, seems rapidly falling into disfavor. There are so very many chances of failure, there are so many connections required, and the result hoped for seems so small an improvement over broadside firing by order, that "*le jeu ne vaut pas la chandelle.*"

Telephones.

The telephone is gradually making its way against the speaking tube. The latter has the advantage of simplicity of principle, the telephone of distinctness. The speaking tube is less apt to get out of order; the telephone does better service when it is in order. The speaking tube is more difficult to lead through the devious labyrinth of the compartments and it occupies valuable space, and while the telephone is not difficult to keep in order, the connecting wires sometimes get disconnected. The telephone has not as yet had a fair chance on shipboard because it is comparatively recently that the long-distance "solid back" transmitter has been introduced. So far as the writer's experience goes, the persons who are not acquainted with this telephone prefer the speaking tube, while those persons who are acquainted with both prefer the telephone.

The principal disadvantage of the telephone for military use is one that it possesses in common with the speaking tube, that is, that it is a very inefficient instrument when used by a person under excitement. With both the speaking tube and the telephone clearness of articulation and a voice not too loud are necessary, if the message is to be quickly and unhesitatingly understood at the other end, and men under excitement are sure to speak loudly and not very distinctly. For the trans-

mission of orders, therefore, and for signaling to the engine rooms, helm and guns, visual indicators are coming into use. Visual indicators possess, besides the advantage of distinctness, the additional advantage that they do not add to the noise on shipboard and are not affected by it, and that the message which they bear remains in evidence until it is replaced by another message, so that "the last order" can always be referred to by a glance of the eye.

The writer has been engaged for some years in perfecting a system of electric apparatus for use in ships and forts which has of late emerged from the experimental stage and seems to contain the possibility of considerable usefulness. Most of this apparatus is based on a central principle of construction which aimed to avoid the inherent difficulty of previous electrical apparatus when used in or near sea air. This difficulty was apparently a trivial but really an almost insuperable one; the sea air attacked and corroded the metallic contacts with which the apparatus was filled. In nearly, if not all, the electrical apparatus used for signaling, the mechanism consisted of a train of wheels which were moved by a pawl and ratchet; the pawl and ratchet being moved, in turn, by an electro-magnet which pulled the ratchet wheel down one tooth every time the current was made and broken. Even the simplest mechanism made on this plan contained many parts, most of them small, and the greatest care was needed to keep everything in order. The only safety lay in hermetically sealing the cases, and this was far from satisfactory and made the mechanism inaccessible. In endeavoring to find a way out of the difficulty, the writer conceived the idea of using only unbroken circuits, which were varied in strength by gradual variations and never by jumps, the variations being indicated by galvanometers and attained by the moving of a wiper over a continuous wire of high resistance. And, as any general discussion of the subject of electricity in naval life would be incomplete if it omitted to mention the labors of even the humblest worker in the field, the writer feels emboldened to introduce to the Institute certain efforts of his own which, with two exceptions that will be designated, have passed official tests in service and are now in use in some of the new ships and are to be installed in others. Beginning with the simplest, he respectfully presents—

The Helm Indicator.

The office of this instrument is to indicate instantly, at certain places in a ship, the exact position of the helm. This is accomplished by means of a device rigidly secured to the rudder post and electrically connected to any desired number of indicators.

The device secured to the rudder post consists of a strip of resistance wire, through which an electric current is passing and over which a metallic contact is moved by the helm; the indicators are galvanometers whose needles deflect to the right and left as the helm moves the traveling contact to starboard and port on the strip of resistance wire, the amount of the movement of said needles being proportional to the amount of movement of the helm and of the contact moved by the helm.

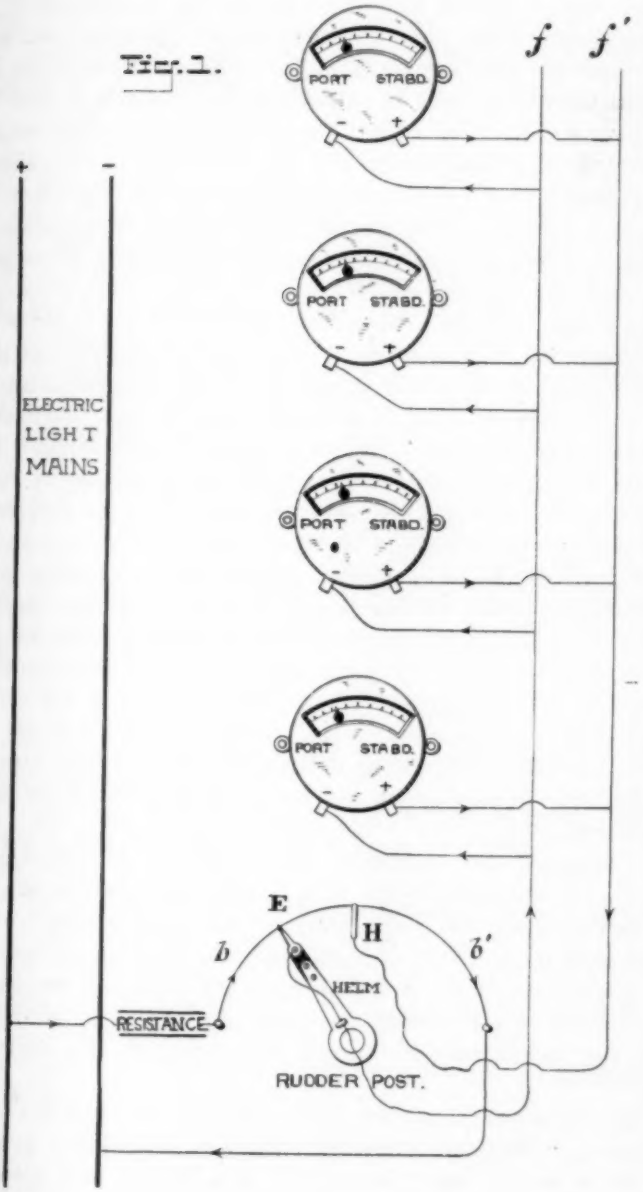
The principle of operation of the helm indicator is shown diagrammatically in Fig. 1. Attached to the helm and insulated from it is the metallic contact E, which continually presses on the arc of resistance wire *b b'*. At the middle of this arc of resistance wire is secured and soldered a permanent metallic contact H. When the helm is amidships, the traveling contact E rests on the permanent contact H, but it is moved to starboard and port of it by the movements of the helm.

A current of electricity continually passes through the resistance wire *b b'*. The current may be furnished by any suitable generator, such as a storage battery, primary battery, dynamotor, etc., but in the diagram it is shown as coming from the ordinary electric light mains of the ship, a suitable rheostat (resistance) being interposed to reduce the current to about 2 amperes. The immediate cause of any current in a wire being a difference of electric pressure (or potential) between the ends of the wire, it follows that there is a difference in pressure between any two points on the wire; so that if a galvanometer be connected to any two points on the wire, a current will be diverted through the galvanometer, going from the point of higher potential to the point of lower potential. In Fig. 1, as the current in the wire *b b'* is going from left to right, as shown by the arrow-heads, the point at E is at a higher pressure than the point at H, so that any galvanometer connected to E and H will be traversed by an electric current in the direction shown by the arrow-heads and the needle will move to the left. If,

HELM INDICATOR

DIAGRAM OF ELECTRICAL CONNECTIONS.

Fig. 1.

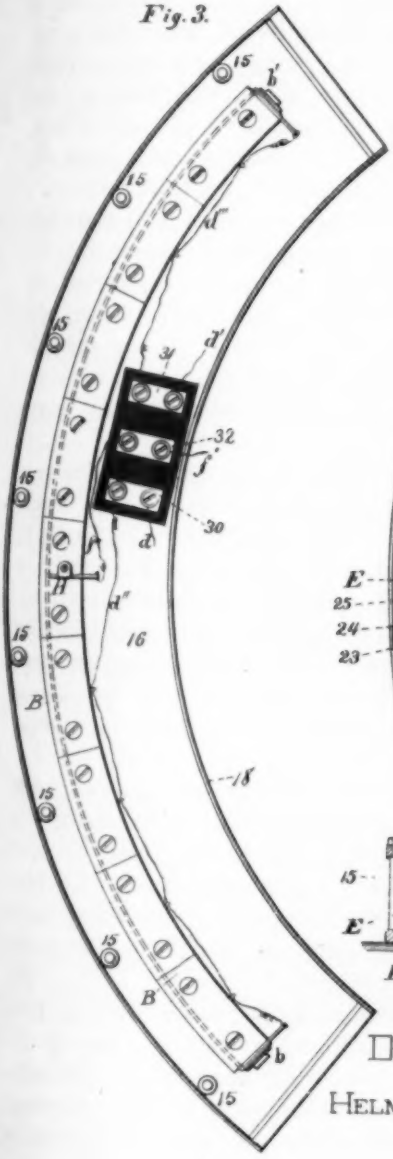


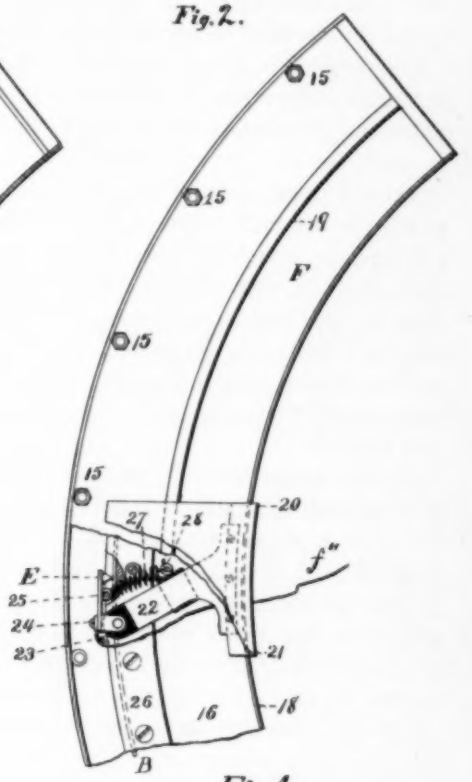
however, the contact E were to the right of H, it would press on a point on the wire which had a lower pressure than H, so that the current would flow through the galvanometer in a reverse direction from that indicated in the diagram and the needle would move to the right. If the contact E rested on H, as it does when the helm is amidships, the contacts E and H would have exactly the same pressure, and no current would flow through the galvanometer, and the needle would not deflect. In the galvanometers employed for this purpose, the position of rest of the needle is at a zero point in the middle of the scale.

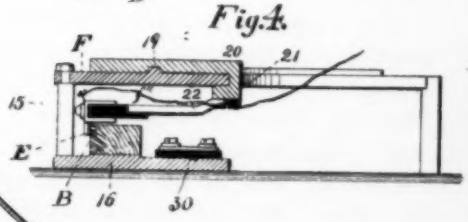
In Fig. 1 there are four galvanometers connected in parallel (or multiple arc) to the wires *f* and *f'* which come from the contacts E and H. The reason for not connecting the galvanometers in series is that an accident to any galvanometer in action, or at any other time, would break the circuit and no galvanometer would operate. But if the galvanometers are connected in parallel, as shown, and if the wires *f* and *f'* are led below the protective deck, any accident to any galvanometer, or its leading wires, will cripple that galvanometer only. As the resistance of each galvanometer is about 60 ohms, and as the wires *f* and *f'* are of copper about No. 16 gauge, and the resistance of the wire *b b'* is extremely small compared with that of each galvanometer, an accident to any galvanometer will not materially change the total amount of current. The current in any one galvanometer, and therefore its deflection, will increase slightly if any other galvanometer be injured and its current broken, but by an amount that is scarcely perceptible, never being more than 1° when the helm is hard over, and being nothing when the helm is amidships.

The resistance wire ordinarily used is the same as that used in the Fiske range-finder—an alloy of 70 parts of copper and 30 of nickel, nearly the same alloy as that used in the United States 5 cent piece. It is No. 22 gauge and has a resistance of about $\frac{1}{3}$ ohm per foot. It is laid in an arc, of which the center is the center of the rudder post and the radius is about 22 inches; the radius may be varied, of course, to suit different places.

In the apparatus constructed for carrying the wire *b b'* and the contacts, called the transmitter, the wire is laid in a groove in an arc of wood, which is secured on a curved base plate of







DETAILS OF CONSTRUCTION
OF
HELM INDICATOR TRANSMITTER.

metal and covered by a similar curved piece of metal. The details of construction are shown in Figs. 2, 3 and 4; and Fig. 5 shows the method of securing the transmitter to the rudder post.

Referring to Figs. 2, 3, 4 and 5, the guide F is a curved plate of metal, supported by standards, 15, which rise from a base plate, 16. The plate 16, guide F and standards 15 form a box, or case, for the arc of wood, B, and movable contact point, E. Upon the upper side of the guide F is a rib, 19, which enters a groove in the under side of the traveling plate, 20. This plate has a flange, 21, which extends around the edge of the guide F. To the plate, 20, the tiller of the rudder is directly connected, so that, as the rudder is swung from one side to the other, the tiller will move the plate, 20, over the guide F. Or any suitable intermediate transmitting mechanism may be interposed between rudder and plate, 20, to cause the stated motion of said plate and contact.

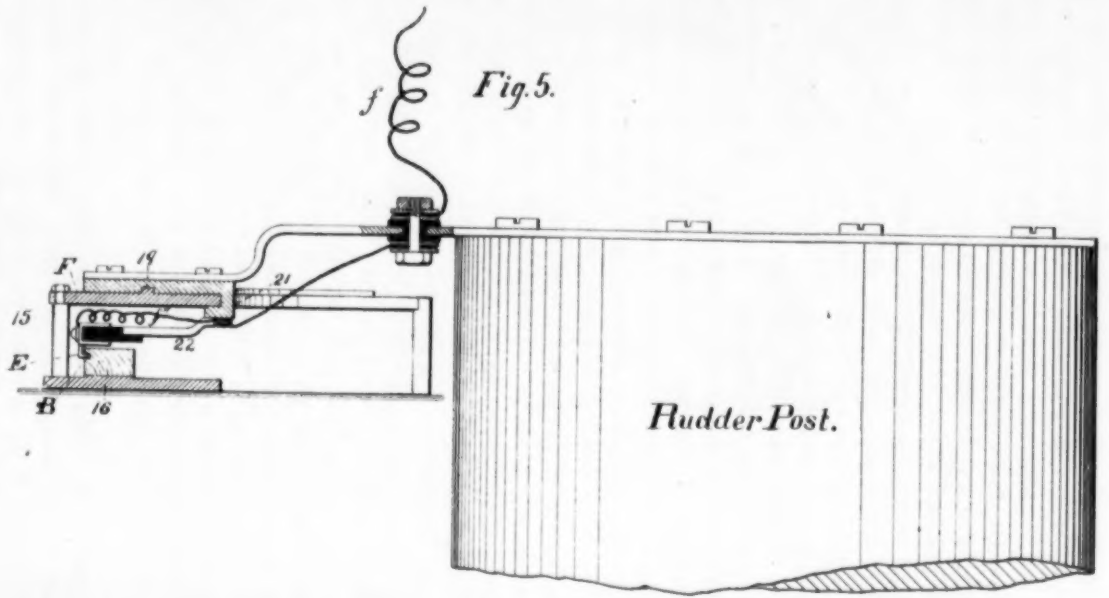
To the flange, 21, is secured an arm, 22, the end, 23, of which is of insulating material and carries a pivoted bracket, 24, which supports a short arm, 25, on the end of which is the contact point E. The arc, *b b'*, of resistance wire is embedded in a groove in the edge of the wooden arc, B, which is secured by screws to the upper side of base plate, 16. Also to said blocks is secured the fixed contact point H. A spiral spring, 27, connected to the arm, 25, and to an eye, 28, held in an insulating block on arm 22, serves to hold the contact point E against the resistance wire *b b'*.

The wires *d* and *d'* are secured to plates 30 and 31, and from those plates the wires *d''* and *d'''* lead to the terminals of the resistance *b b'*. The wire *f'* connects to a similar plate, 32, and from this plate the wire *f''''* leads to the fixed contact H. The wire *f*, Fig. 5, is connected to a plate on the arm extending from the rudder post to the traveling plate, 20, and from this plate the wire *f''* leads to the contact piece E.

The resistance wire *b b'* should be kept covered with a thin film of oil, or vaseline. If this is done the friction of the traveling contacts will not cause the wearing away of the contacts or the wire, and the contact will move smoothly without jumping.

In case of trouble with this apparatus, the cause will be found in nine cases in ten to be a faulty contact.

In some cases the details of the transmitter have to be



METHOD OF CONNECTING HELM INDICATOR TRANSMITTER TO RUDDER POST.

changed slightly in order to make it fit in certain places; for instance, the sliding plate, 20, sometimes has a flange fitting around the outside edge of the base plate, 16, instead of around the inside edge.

The galvanometer usually employed in the helm indicator, steering telegraph and engine telegraph is like that used in the Fiske range-finder and range-indicator and is illustrated in Fig. 6. The current passes through a light coil of wire in the form of a bobbin pivoted between the poles of a stout magnet, M. It is held normally at a position of rest in the middle of the scale by two spiral or volute springs, one at each end of the pivot. The effect of a current going through the coil of wire is to turn the coil in one direction or the other according to the direction of the current, and this tendency is resisted by the springs, so that the needle assumes a resultant position, in which the force of the springs just balances the magnetic force operating between the magnet and the current, the movement being small or great according as the current is small or great.

The galvanometer is mounted in a heavy water-tight case. In the helm indictator and steering telegraph circuits, the cases are usually made of heavily japanned cast iron, both for strength and for the reason that the iron case acts as an armature to the magnet inside, and decreases the effect of the magnet on any compasses in the vicinity. But an indicator should not, if possible, be closer to the compass than three feet.

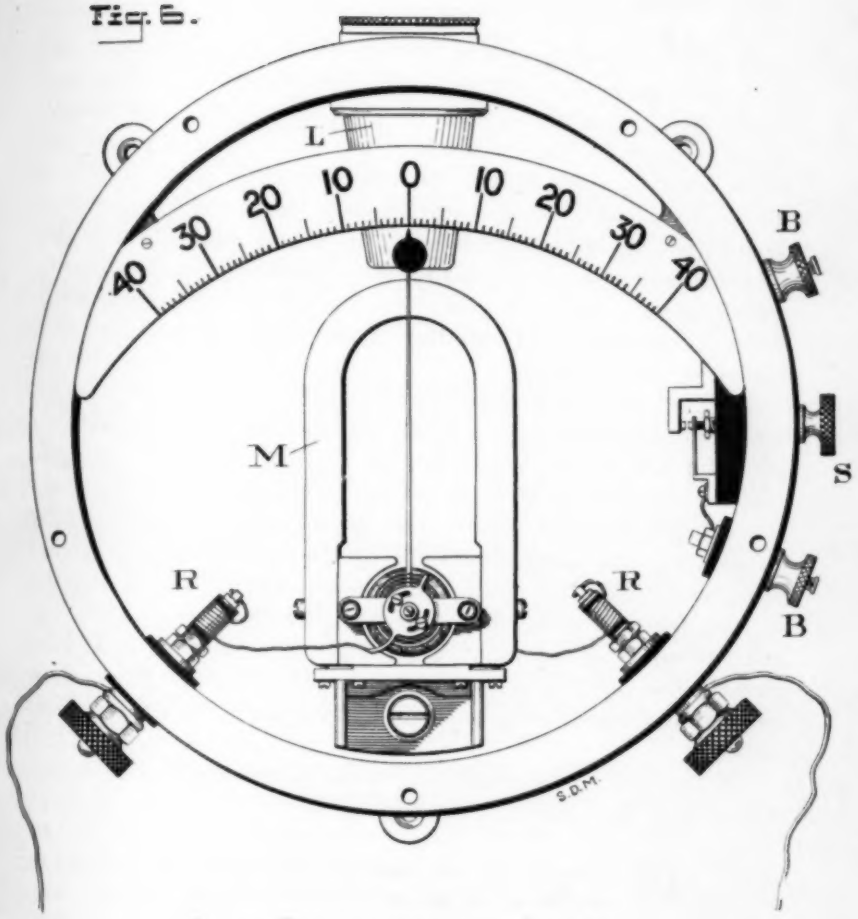
The iron cover carries under it a strong circular plate of glass, held on to it by an iron ring. The circumference of the glass is encircled by a rubber band, between which and the glass, white lead is placed to insure water-tightness. For the same purpose, white lead is thickly laid in the grooves for the glass plate in the cover and the iron ring, so that, when the iron ring is screwed on to the cover (the glass being between), the complete cover thus formed is itself water-tight. Before screwing the cover on to the galvanometer case, a rubber gasket is secured to the case by shellac. When the cover is screwed on, it forces the gasket into such intimate contact with the case that it cannot afterwards be pulled off without tearing. Shellac and white lead are omitted between the cover and the rubber gasket, in order to make it easy to take off the cover, if it becomes necessary. To make the case water-tight, therefore, the cover must be screwed on tight.

GALVANOMETER

ARRANGED AS

INDICATOR

Fig. 6.



L = Incandescent Lamp

R R = Coils German Silver Wire For Adjusting Sensitiveness Of Galvanometer

Note.—In case a needle gets bent it may be straightened with the fingers. But if, when at rest, it does not point to o, and yet is straight, the trouble is that the little clamping screws near its pivot, shown in Fig. 6, have slipped. In this case these screws must be slackened and the needle turned carefully on its pivot until it points correctly, and then the little screws re-tightened.

A space of about $\frac{1}{32}$ inch is left between the glass and the outer iron plate in order to protect the glass against any blow that might be transmitted through the iron plate. To drain off any water that might run in between the glass plate and the iron plate, a quarter-inch hole is cut near the lower part of the iron plate. The helm indicator was given a year's test in service on board the armored cruiser New York. It has since been installed in the battle-ships Indiana and Massachusetts, using five indicators in each ship, the year's test having been passed successfully. It is now being installed in the Texas, and is to be installed in the Brooklyn.

To illuminate the indicators of the helm indicator and steering telegraph for night use, a small electric lamp L is introduced into the case as shown in Fig. 6. It lies within a stationary water-tight glass receiver, or globe, so that it can be taken out for inspection when desired, and replaced by another lamp, if necessary. The lamp may be lit by the current from a storage battery, or from the electric light mains of the ship, connected to the binding posts, BB, resistance being interposed to cut the current down to about $\frac{1}{3}$ ampere. The lamp is lighted by turning the water-tight switch shown at S, Fig. 6. The scale is printed on card-board secured on a brass gauze translucent backing.

The copper wires connecting the instruments should not be less in size than No. 16 American gauge.

Note.—Fig. 6 shows coils of resistance wire inside of the case for adjusting the sensitiveness of the galvanometer. Where extreme accuracy is required it becomes necessary to have an adjustable resistance outside the case as in the Fiske range-indicator, in order to compensate for sudden variations in the strength of the magnet due to changes of temperature. But this refinement is not considered necessary in helm indicators or steering telegraphs.

Weight of transmitter 35 pounds. Weight of indicator 22 pounds; diameter 10 inches, resistance 60 ohms.

The Steering Telegraph.

The office of this instrument is to telegraph from certain places in a ship to the steering wheels, the position at which it is desired to put the helm. This is accomplished by means of certain apparatus, called transmitters, placed where desired and electrically connected to indicators secured in conspicuous positions near the steering wheels. The principle on which the system depends is the same as that on which the helm indicator depends, the transmitters consisting of strips of resistance wire, through which currents of electricity are passing and over which traveling contacts are moved by an operator, while the indicators are galvanometers connected electrically to these contacts.

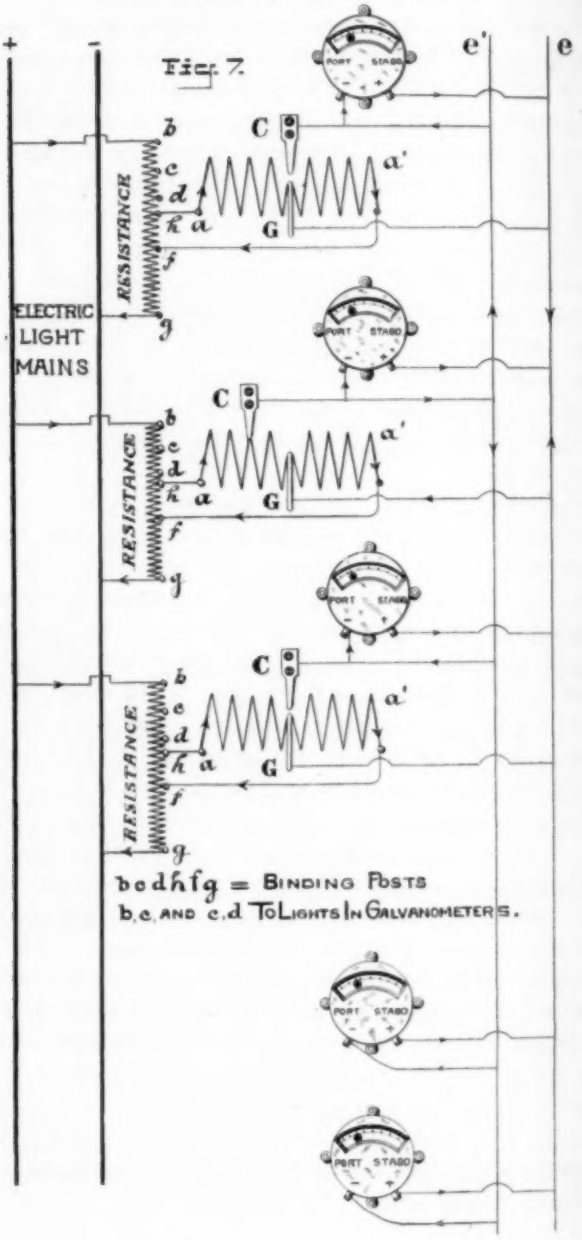
Fig. 7 is a diagram of electrical connections for a steering telegraph system, comprising three transmitters, shown on the upper part of the page, and two indicators shown on the lower part of the page.

The resistance wires $a\,a'$ are traversed by currents of electricity, furnished by any suitable source, such as a storage battery, primary battery, dynamotor, etc.; in Fig. 7 the source is the electric light mains of the ship, a suitable resistance being interposed, as shown, to reduce the current in each transmitter to about 2 amperes. The passage of a current of electricity through the resistance wire of any transmitter, such as the second transmitter shown in Fig, 7, is immediately due to a difference in electric pressure, or potential, between different parts of the wire; so that the permanent metallic contact G and the traveling contact C are at different pressures or potentials. If the current is flowing in the direction represented by the arrow-heads, contact C is at a higher potential than G, so that a current of electricity will pass through any galvanometer connected to them, going in the direction from C to G and move the galvanometer needle to the left. If, on the other hand, C were to the right of G, it would be at a lower potential and the current through a galvanometer connected to C and G would go in the direction from G to C and move the galvanometer needle to the right. If the contact C were at the middle part of the wire and rested on G, C and G would be at the same potential and the galvanometer needle would remain at rest in the middle of the scale.

STEERING TELEGRAPH

DIAGRAM OF

ELECTRICAL CONNECTIONS



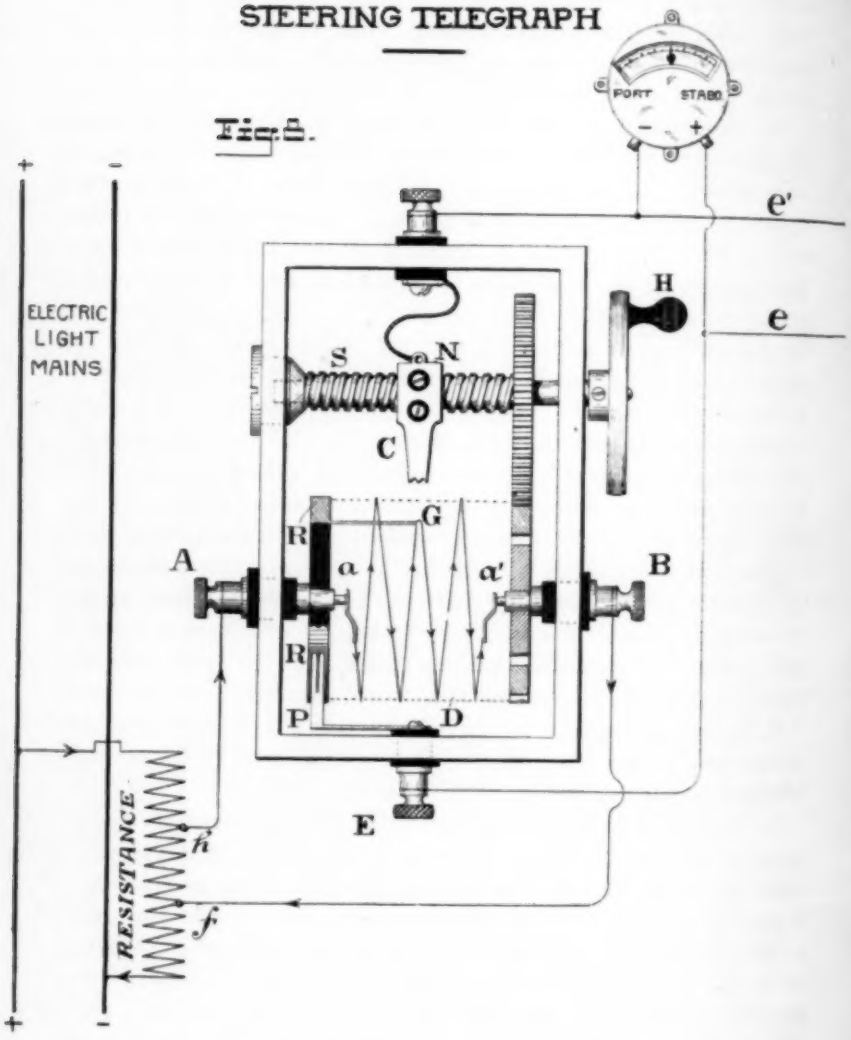
In order that two or more transmitters may be connected independently, and yet be so adapted that any one transmitter may be used at any time, the contact C and the wire G are so arranged that the contact C does not touch the wire when it is in its middle position. So long, therefore, as the contact C of any transmitter is in its middle position, that transmitter is not connected to a galvanometer and does not affect any galvanometer or any other of the transmitters. In the position shown in Fig. 7, the movements of contact C of the second transmitter affect the galvanometers just as though the first and third transmitters were absent. When not in use, the contact of each transmitter should be placed in its middle position, not touching the resistance wire. This caution is marked on each transmitter case. The amount of the movement of contact C may be shown on a graduated scale and the resistance in the circuit so adjusted and the galvanometers so marked that the galvanometer needles will point to the figure that indicates the movement of the contact C. This method is like that adopted in the helm indicator, but a preferred method is that shown in Fig. 7, because the system is not affected by any changes of electro-motive force of the generator, and the work of adjusting the resistance is avoided. By the plan shown in Fig. 7, there is placed in front of each transmitter a galvanometer exactly similar to the galvanometers which act as indicators at the steering wheels. The operator, then, at any transmitter, moves his contact until the galvanometer in front of him points to the desired helm position—say 20° port; and the two indicators at the steering wheels will instantly show 20° port.

A further advantage of the use of this galvanometer at the transmitter is that the operator always knows by its movements whether or not the apparatus is working.

In the absolute apparatus, as ordinarily constructed, the resistance wire *a a'* is wound in a spiral groove on the circumference of a cylinder D of insulating material, such as rubber, as indicated in Fig. 8. The two ends of the wire are connected to flat springs *a a'* against which press the ends of the binding posts A, B. The permanent contact G is connected by a short pin to a metallic ring R placed at one end of the cylinder; and a flat spring P connected to the binding post E continuously presses on the ring R. At the point where the permanent contact G is connected to the wire, the groove in the cylinder is cut

TRANSMITTER OF STEERING TELEGRAPH

Fig. 5.



down deep into the cylinder, so that the contact C cannot touch it. To accomplish this, in constructing the apparatus, the cylinder D is cut in half transversely, and the contact G, after being soldered to the wire which is to be wound on the cylinder, is secured in position. Then the two halves of the cylinder are screwed together and the wire is wound in the groove. To produce movement of the contact C, it is mounted on the nut N which travels on the screw S, C being insulated from N. The pitch of the screw S and of the spiral thread in the cylinder D are the same, so that, as S is revolved by turning the handle H (thereby turning D by means of the gear-wheels shown), the nut N is moved along the screw S, and the contact C along the wire *a a'*, the contact always remaining in the groove that holds the wire.

The copper wires connecting the instruments should not be less in size than No. 16 American gauge.

The transmitters of the steering telegraph are so arranged that any transmitter can be used independently of any of the others and produce the corresponding deflections in all the galvanometers, both of the transmitters and receivers, so long as both of the other transmitters are secured carefully at o; but any movement of any transmitter while another is in use is indicated immediately by the erratic movements of all the galvanometers. In order to show clearly when a transmitter is at o, a glass is placed in its face through which the sliding contact can be seen. When the transmitter is at o, the reference mark on the sliding contact is directly in line with the zero mark in the transmitter; and it can be secured in this position by means of a stout pawl which falls into a slot cut in the handle H, Fig. 8.

The steering telegraph was given a year's test in sea service on board the U. S. S. New York, and the test having passed successfully, the apparatus has since been installed in the U. S. battle-ships Indiana and Massachusetts, using in each ship three transmitters and two indicators. It is now being installed in the Texas, and is to be installed in the Brooklyn.

Weight of indicator, 22 lbs.

Resistance of indicator, 60 ohms.

Weight of transmitter box, 6 lbs.

Diameter of indicator, 10 inches.

STEERING TELEGRAPH.

TRANSMITTER.

FIG. 8 A.

The Engine Telegraph.

The office of this instrument is to signal to the engine-rooms the speed and direction at which it is desired to run the engines.

The telegraph for each engine consists of a transmitter and a receiver, in each of which is an arc of resistance wire. The ends of the resistance wires of transmitter and receiver are connected together by large copper wires, so that they form, with the galvanometer, a "Wheatstone bridge" circuit (see Figs. 9 and 10); and since the two arcs of wire are exactly similar, the galvanometer will not deflect, if the contacts to which the galvanometer is joined are placed on the resistance wires at similar points, such as 1.1, 2.2, etc. In the actual apparatus, the contacts of the galvanometer are attached to the levers on the instruments; so that, if the operator at the transmitter places his lever at any point, the galvanometer will not deflect, if the operator at the receiver places his lever at a similar point.

The operation, then, of using the telegraph is as follows:

The operator on the bridge, or in the pilot-house or conning-tower of the ship, wishing to signal an order, places his lever opposite the graduation on the transmitter indicating the order. The operator in the engine-room moves his lever until the galvanometer comes to zero, and then looks at the face of his receiver, to see the graduation opposite to which his lever then is.

Besides the galvanometer just mentioned, there is another galvanometer in series with it. This galvanometer is on the bridge, and is subjected to the same electrical current as is the galvanometer in the engine-room, and is moved to the same extent. The operator on the bridge, therefore, by looking at this galvanometer can tell whether or not the galvanometer in the engine-room is at zero; or, in other words, can tell whether or not the operator in the engine-room has moved his pointer to the signaled position; so that the galvanometer on the bridge acts as an answering signal to the operator there. The galvanometer in the engine-room is mounted in a vertical position on the lever of the receiver, so that the galvanometer and lever move together. (See Figs. 11 and 16.) Its electrical connections are such, that if the needle points in any direction, the act of moving the lever of the receiver in that direction will bring the needle towards zero. Furthermore, the sensitiveness

ENGINE TELEGRAPH

— DIAGRAM OF —

ELECTRICAL CONNECTIONS

Fig. 9

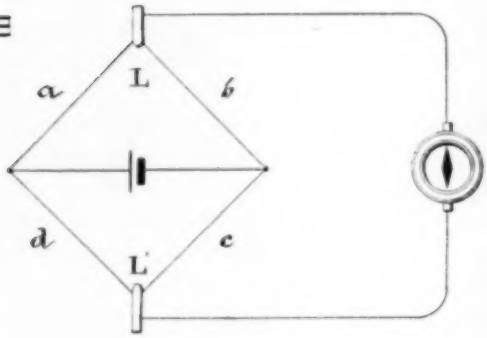
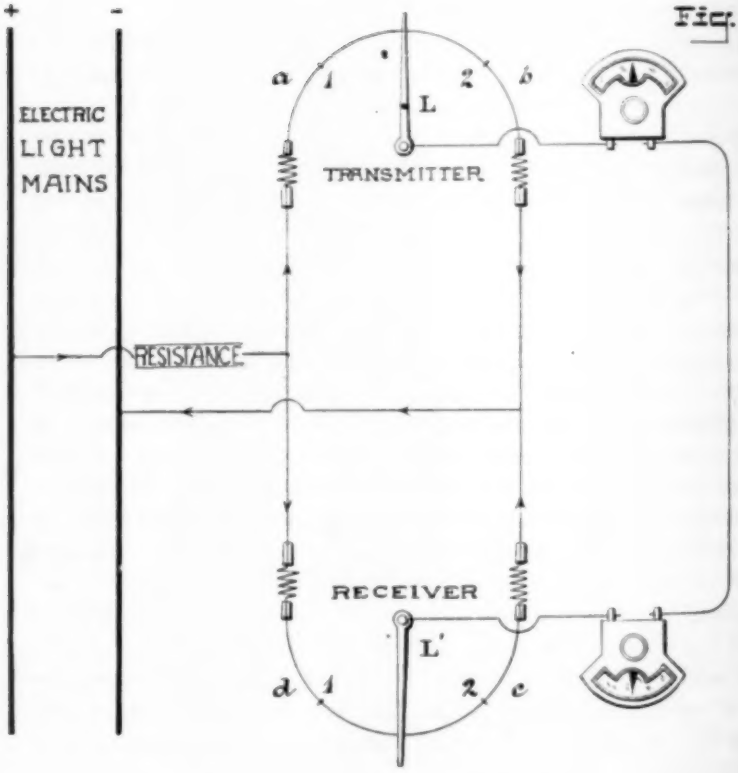


Fig. 10.



of the galvanometer is so adjusted during installation that the amount of deflection of the needle shows the amount of movement necessary to give the lever. If, therefore, the levers are at 75 and the transmitter lever is moved to 90, the receiver galvanometer will at once point to 90. When the needle is at zero, it is in a line from the center to the indicating finger on the lever; so that, in order to bring the needle to zero, the operator at the receiver moves his lever towards the needle and until it is directly opposite it. In other words, the mode of procedure of the operators, both on the bridge and in the engine-room, is the same as it is with the ordinary mechanical engine-telegraph.

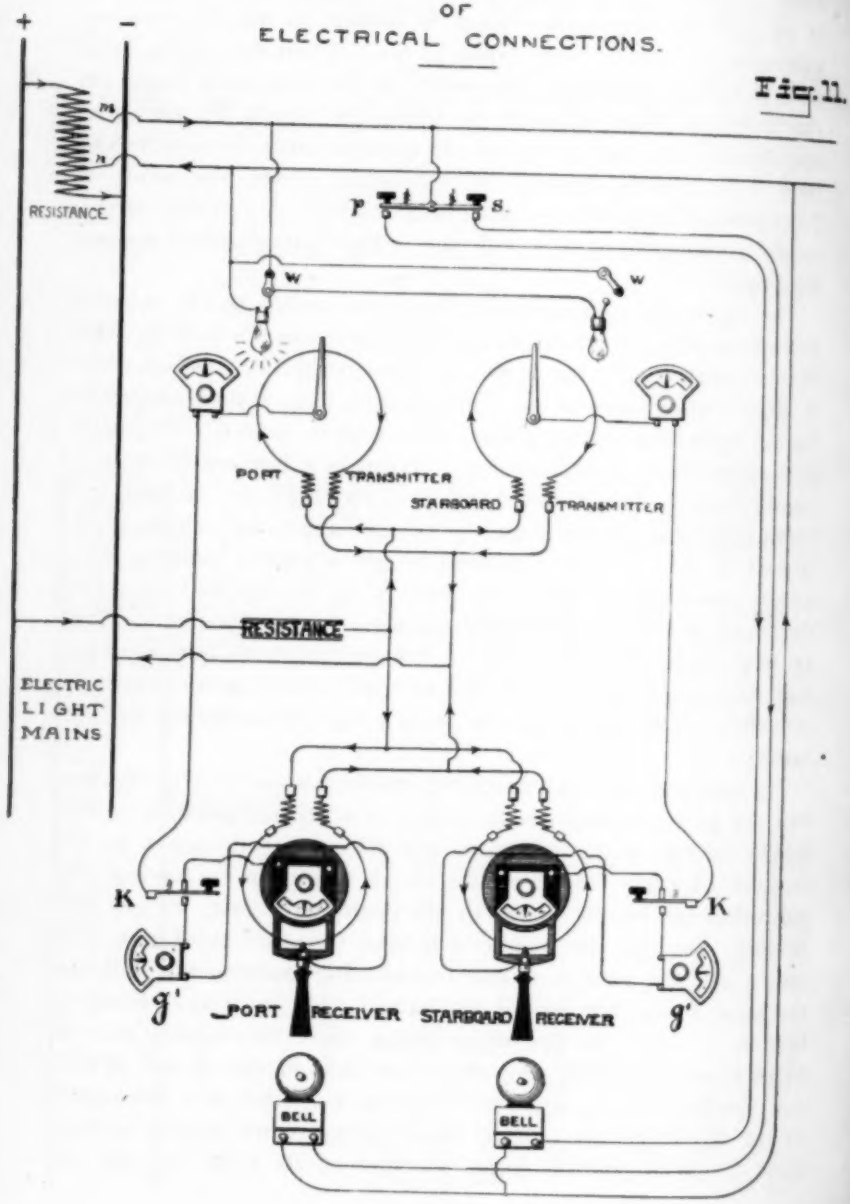
The receiver's galvanometer, however, owing to the vertical position in which it stands, is not absolutely exact. It is possible to make with it an error of two or three revolutions. This error is of no consequence in the ordinary use of the engine-telegraph, but for squadron sailing greater exactness is desired. To insure this, an auxiliary galvanometer *g'* lying in a horizontal plane is placed directly below the receiver. (See Figs. 11, 16 and 17.) Ordinarily, this galvanometer is not in circuit, and no attention is paid to it; but if it is desired to get a careful reading, it is merely necessary to press the key K on its top and to move the lever of the receiver until its needle comes to zero. The act of pressing the key on top of this galvanometer puts the current through it and out of the vertical galvanometer which is ordinarily used, but does not disturb the galvanometer on the bridge.

The expression, "galvanometer needle comes to zero," means that the galvanometer needle comes to a marked position in the middle of the scale, but does not mean that it comes to its position of rest. There would be an objection to having the galvanometer needle come to its position of rest, to get the reading; because the needle will take its position of rest, not only when the receiving and transmitting instruments indicate the same thing, but also if the battery fails, or if the circuit is broken; so that the operators might think the system was in balance and operating properly, when, as a matter of fact, it was not operating at all, and would fail the first time they attempted to use it. For this reason, each galvanometer needle is bent away from the middle point marked on its scale, so that its

ENGINE TELEGRAPH

DIAGRAM
OF
ELECTRICAL CONNECTIONS.

Fig. 11.



position of rest is about $\frac{1}{16}$ of an inch from this mark; but the electrical adjustments are such that, when the levers of the transmitting and receiving instruments are at similar places, the "bridge" is not exactly in balance, but is out of balance just enough to bring the needles back to the middle marks or zero. Therefore, the fact of these needles being at zero is proof that the circuit is in balance, that both the transmitting and receiving instruments indicate the same thing, and that the whole apparatus is in perfect order. If, therefore, the operators at each end see that their needles are at zero, they know that everything is all right; but if at any time they see the needles are not at zero, they know that something is wrong. The first effort will naturally be to move the lever, in order to return the needle to zero, thinking that some person may have displaced the lever. But as soon as they see that this does not alter the position of the needle, they know that the instrument requires attention. *In other words, this system detects itself, if it gets out of order, and reports itself at once, instead of waiting until some one tries to use it* and then failing in an emergency, as mechanical telegraphs often do.

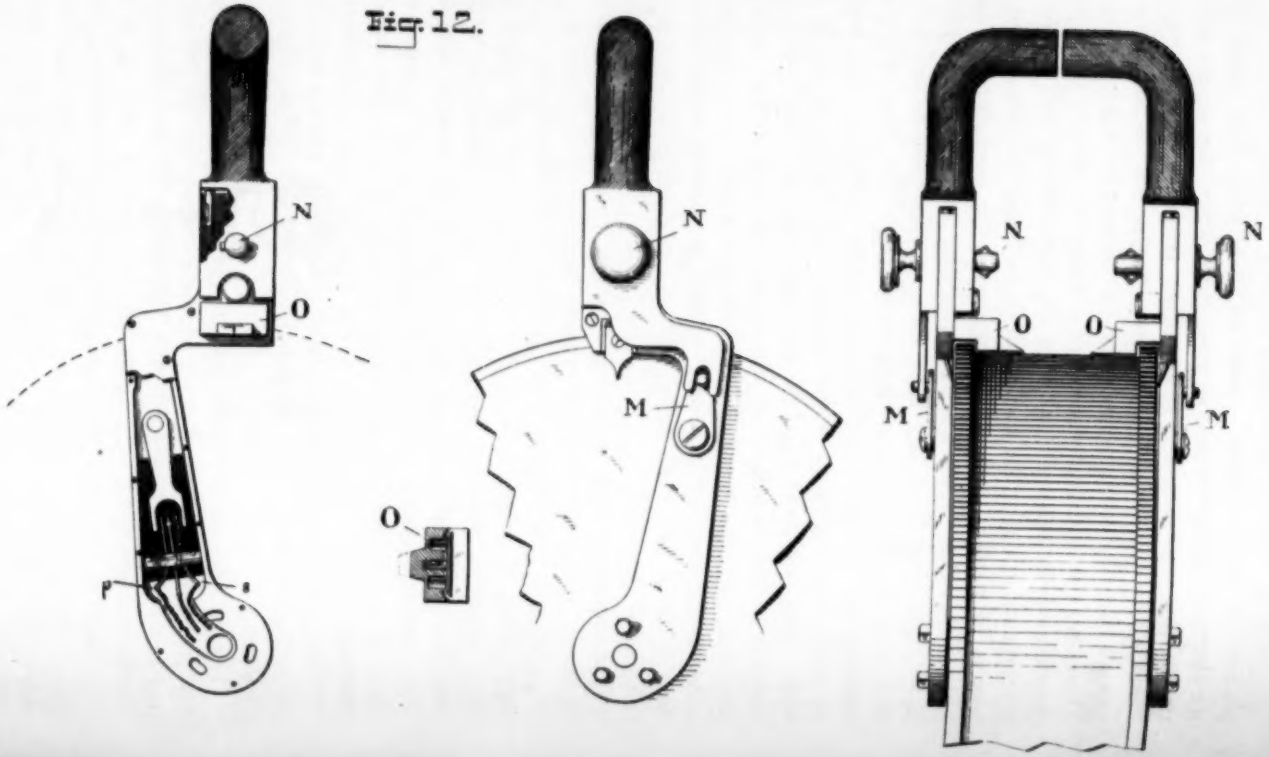
The apparatus may be operated either from a dynamo current or from a storage battery, or primary battery, or dynamotor. In Figs. 10 and 11 it is shown as operated from the regular electric light mains of a ship, a suitable resistance, about 38 ohms, such as a Carpenter rheostat, being interposed, to reduce the current sufficiently to make the galvanometers of the proper sensitiveness, which requires about 2 amperes, or about 1 ampere in each telegraph circuit, starboard or port, or $\frac{1}{2}$ ampere in each resistance wire. As shown in Fig. 11, one pair of connecting wires is made to do the service of connecting both transmitters to both receivers. The resistance of each arm of the "bridge" is about 3 ohms.

The circuits of the bells and of the lamps which illuminate the transmitter are connected to the dynamo circuit through a resistance as shown in Fig. 11. The lamps for illuminating the transmitter are lit by turning the small screws W, Fig. 14, at each side, and can be taken out and replaced by others if found defective. These lamps are about 1 candle power, and are placed inside the reflectors shown on top of the galvanometer cases, *g*, on each side of the transmitter. The lamps and bells usually

TRANSMITTER HANDLE

—ENGINE TELEGRAPH—

Fig. 12.



ENGINE TELEGRAPH.

DOUBLE TRANSMITTER.

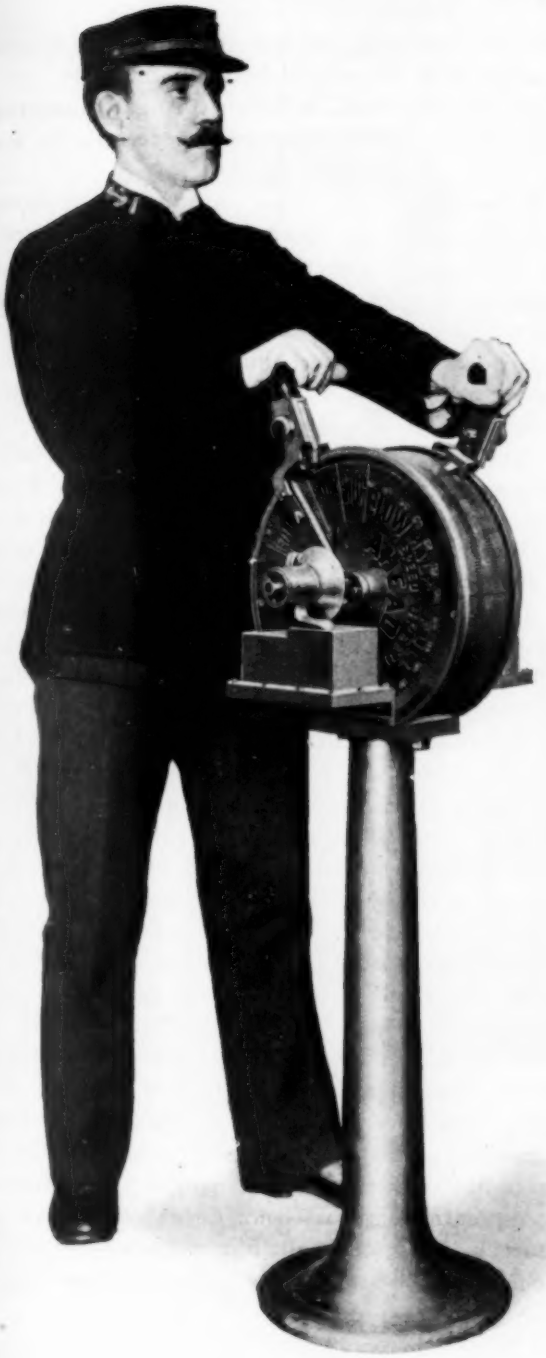


FIG. 13.

require about 10 volts each; so that the difference of potential between *m* and *n*, Fig. 11, should be about 10 volts.

Any part of the apparatus, including the galvanometers, can be taken apart, examined and repaired, if necessary, by a careful mechanic.

The arcs of resistance wire in the transmitter and receiver on which the contacts move are covered with vaseline before being installed, in order to prevent undue friction between the wire and the traveling contact. These wires should be examined from time to time and more vaseline put on as required. They should always be covered with a thin layer of vaseline or oil.

The act of grasping one of the handles of the transmitter closes the electrical contact P or S on the lever (see Figs. 11 and 12 and 14) by means of the lever M, and rings a bell in the corresponding engine-room. The bell contacts are covered in and arranged as shown in Fig. 12, and well protected from dirt and water. Water in these contacts will not close the circuit, but if they should get dirty they might not permit the closing of the bell circuit when desired. The transmitter handles may be taken off by pulling out the pin N. These handles are held in position on the rim of the transmitter by means of the spring friction piece in the sliding piece O.

In case of any trouble with the engine-telegraph, the difficulty, in nine cases out of ten, can be traced to some imperfect contact. The contacts most likely to require attention are those of the key K on the top of the small horizontal galvanometer *g'*, under the receiver. If these contacts fail to touch each other, the galvanometer on the bridge and the vertical galvanometer in the engine-room will not receive any current, and therefore their needles will not deflect.

A considerable amount of insulated resistance wire, about 2½ ohms, is added to each end of each arc of wire, as shown in Figs. 10, 11, 15 and 17, in order to increase the amount of resistance in circuit of this kind of wire, in comparison with the resistance of the copper connecting wires. This makes the resistance of the resistance wires in each arm of the "bridge" about 3 ohms. The reason of this is that copper changes in resistance with change of temperature, and it is not desirable to have changes of temperature to alter materially the resistance of the circuit. The resistance wires *a b* and *c d* are of No. 22 American gauge,

ENGINE TELEGRAPH.

DOUBLE TRANSMITTER.

Rear View.

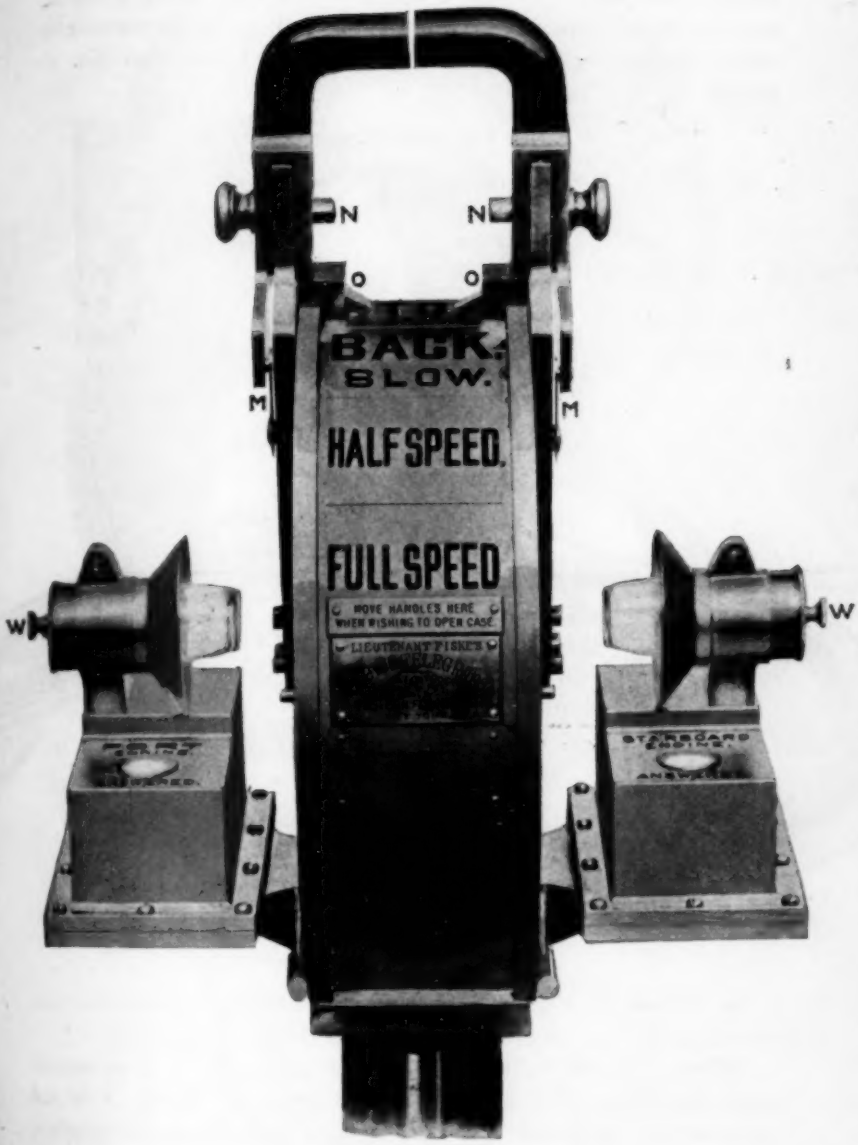


FIG. 14.

and made of range-finder alloy, *i. e.* 70 parts copper and 30 of nickel, with a resistance of about ⅛ ohm per foot. The copper wires connecting *a b* to *c d* are No. 6 gauge, being made so large to avoid copper resistance. The bell wires, galvanometer wires, electric light wires, etc., must be not less than No. 16 gauge.

ENGINE TELEGRAPH.

DOUBLE TRANSMITTER.

Case Open.

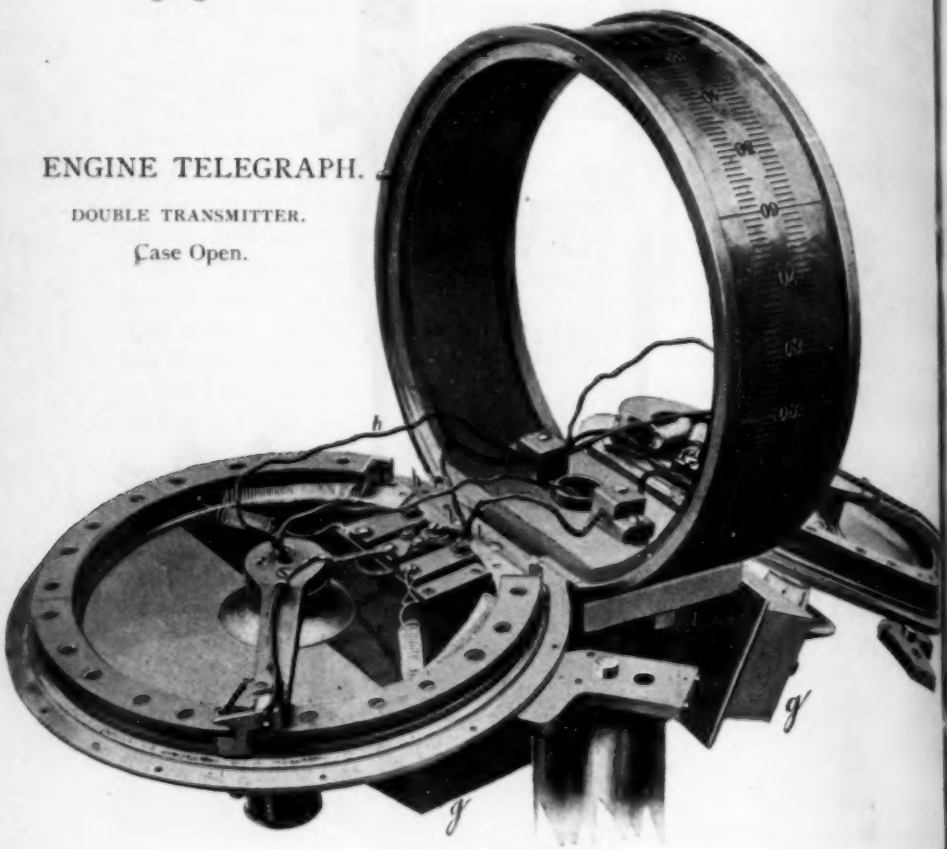


FIG. 15.

As shown in Figs. 13, 14 and 15, both the transmitters are mounted on one pedestal and form a double transmitter.

When there is but one engine, the apparatus is correspondingly simplified and cheapened. In the case where it is not necessary to signal any exact number of revolutions, the graduations for revolutions on both transmitter and receiver, and the

ENGINE TELEGRAPH.

RECEIVER.

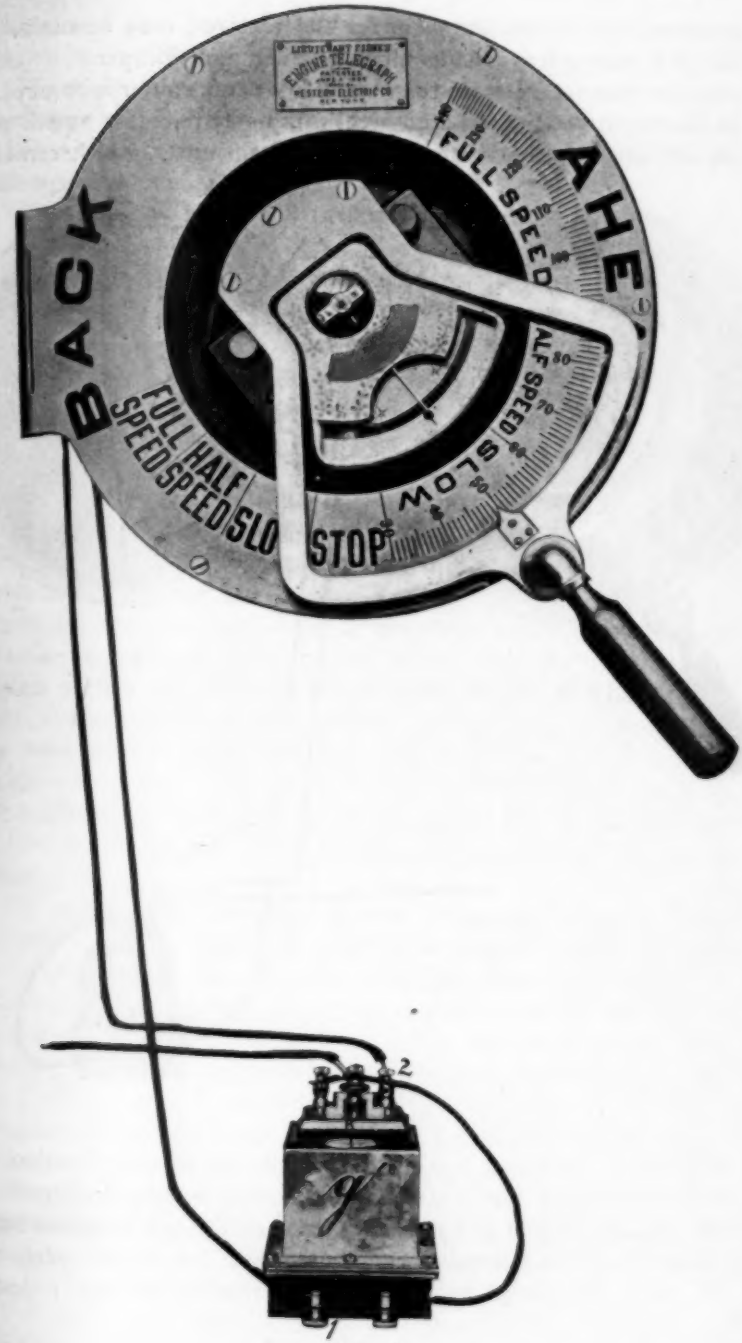


FIG. 16.

horizontal galvanometer g' under the receiver, may be omitted and the instruments made much smaller and cheaper.

In the case where more than one double transmitter is required, as in the Brooklyn, where three will be required, a switch is placed on the pedestal of each double transmitter, which carries

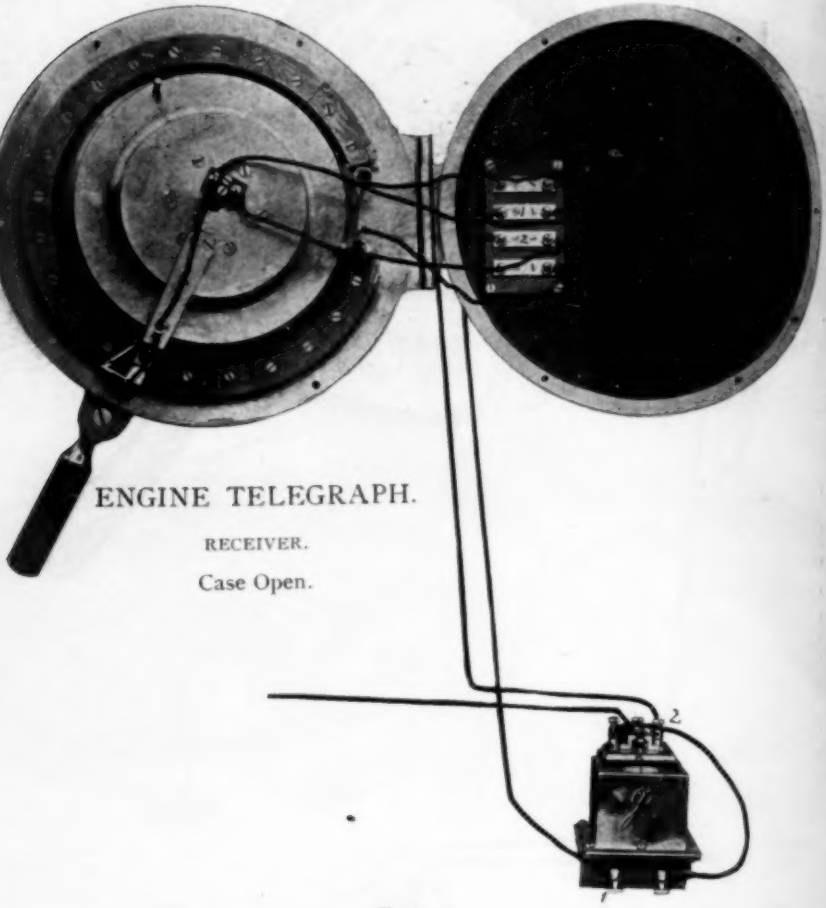


FIG. 17.

four knife contacts. By moving this switch in one direction, or the reverse, the connection is made or broken to both ends of the resistance wire *a b* and both ends of the galvanometer wire. To get ready any transmitter for use, then, it is merely necessary to move its switch in the direction marked on the pedestal.

When any such transmitter is not in use, its switch must be moved to the "not in use" mark.

The covers of the transmitters and receivers are made to open on hinges, as shown in Figs. 15 and 17 respectively, so that the connections are readily accessible for examination. Before endeavoring to open the transmitter take off the handles.

The copper leading wires within the transmitters and receivers that are connected to the forward ends of the arcs of resistance wire are covered with yellow braiding; those connected to the after ends with green braiding; those to the galvanometers with green-yellow braiding; those to the bell contacts in the transmitter handles with red-yellow braiding, and those to the lamps with black braiding.

For engines whose speed ranges between 30 and 140 revolutions, the arms which carry the contacts that move over the resistance wires in both the transmitters and the receivers are so connected to the handles that, when the handles are at 85 revolutions ahead, the contacts are at the middle points of their respective arcs; and in constructing and installing the instruments the 85 revolutions mark is the place where the most care is taken to make the instruments balance exactly. The reason of this is that, since the resistance wires are never exactly uniform, the farther away the contacts get from the middle points, the more error is apt to creep in; and by making 85 revolutions as the middle point, the contacts do not get far away from it in either direction, even when going as fast as 140 revolutions, or as slow as 30; so that errors as great as ½ revolution are rarely found.

For engines whose maximum speed is greater than 140 revolutions, or less, the same rule applies, though the middle graduation will, of course, be some number greater than 85, or less.

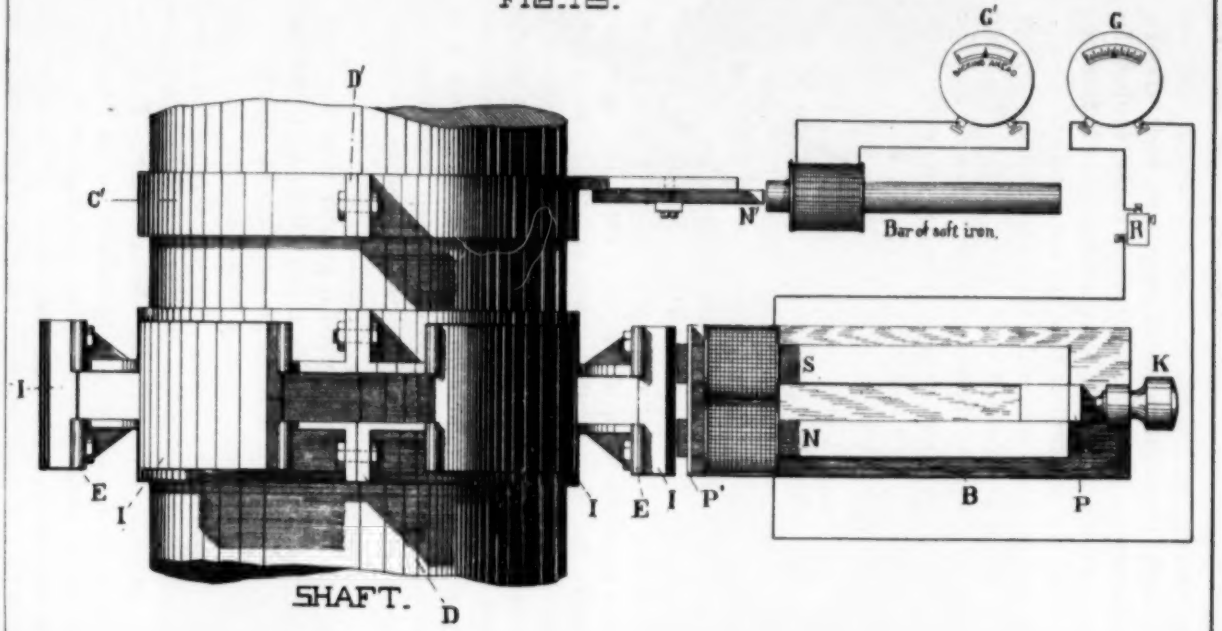
This engine telegraph was given a year's trial in sea service on board the U. S. S. New York. The test having been successfully passed, the apparatus has since been installed on board the U. S. S. battle-ships Indiana and Massachusetts. It is now being installed in the Texas, and is to be installed in the Brooklyn.

Weight of double transmitter complete, 140 lbs.

Weight of receiver complete, 80 lbs.

Diameter of face of transmitter or receiver, 14⅝ inches.

FIG. 18.



LIEUTENANT FISKE'S SPEED AND DIRECTION INDICATOR.

The Speed and Direction Indicator.

The office of this apparatus is to indicate at a distance the speed and direction of revolution of the shaft of an engine, or any other shaft.

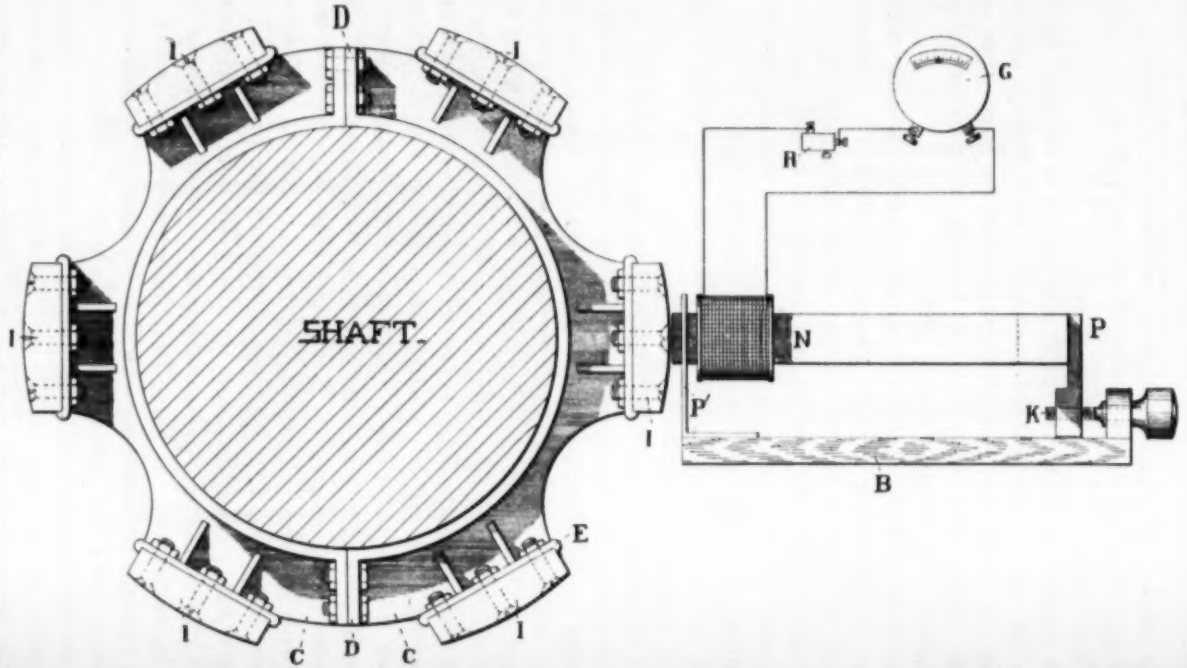
The underlying idea is an apparatus which is actuated by the shaft, but has no mechanical connection to it, which operates entirely by itself, and without intervention or care from any outside source; and which has no belting, or gearing subject to slipping, or to wearing out in service.

The speed indicator (direct reading) consists, broadly speaking, of an alternating current system, in which the alternating currents are induced by the rotation of the shaft, being great or small according as the shaft moves rapidly or slowly; and of an alternating current indicator, which indicates the magnitude of the current, and therefore the speed of revolution.

The direction indicator consists also of an alternating current system actuated by the motion of the shaft.

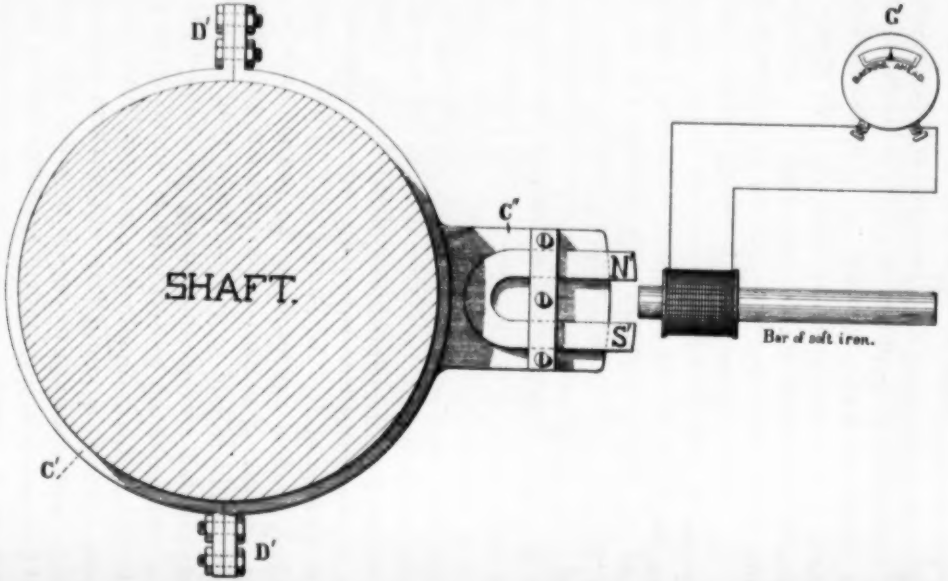
The apparatus is shown in Figs. 18, 19, 20, 21, and 22. Fig. 18 shows both circuits connected to their respective indicators. Mounted on the shaft are two rings, C and C'. Each ring is in halves, which fit the shaft, and these are clamped on, as shown, by lugs at D and D'. (See also Figs. 19 and 20, in which Fig. 19 shows the part pertaining to the speed indicator, and Fig. 20 shows the part pertaining to the direction indicator.) Secured on the ring D, or rather on a web that is cast on ring D, are, say, six soft iron inductors, I. These inductors, when revolved by the shaft, pass in front of the poles of the magnet S N. On the poles of the magnet S N are two coils of wire, and these are connected to the alternating current indicator G. When one of these inductors, I, is directly in front of the poles S N, the magnetic flux passing through the two coils is at its maximum. When no iron inductor is near the poles S N, the magnetic flux is at its minimum. As these iron inductors revolve before the poles, consequently the magnetic flux is increased and decreased as many times per revolution as there are inductors. Each increase and decrease of the magnetic flux produces an alternating current in the coils, according to principles well understood, and the more rapid the increase and decrease, the greater the electro-motive force induced. It is evident that, in manufacture,

FIG. 19.



LIEUTENANT FISKE'S SPEED AND DIRECTION INDICATOR.

FIG. 20.



LIEUTENANT FISKE'S SPEED AND DIRECTION INDICATOR.

it is possible, with a proper construction of the apparatus and with a proper proportioning of the parts, to so control the inductance of the circuit, and to so arrange the inductors and the number of them, that the current in the circuit shall increase very considerably as the speed of the rotation of the shaft increases. In the drawings, the magnet S N is shown as a permanent magnet. Of course it can be an electro-magnet, if desired. If a permanent magnet, the steel must be specially hardened, in order that it may not lose its magnetic strength with age.

It is advisable, in the construction of the apparatus, to introduce an adjustment for controlling the air gap between the inductors I and the magnet poles N S, and, therefore, the magnetic flux and the strength of the current generated. The adjustment is accomplished by mounting the magnet S N on the two supports P and P', Figs. 18 and 19. By turning the screw K in one direction or the other, the magnet poles are moved longitudinally in the stationary support P', and moved closer to, or further from, the inductors, thus increasing or decreasing, at will, the strength of the currents generated. The usual distance is about $\frac{1}{16}$ inch. In installing the apparatus, it is merely necessary to adjust the distance until G indicates correctly.

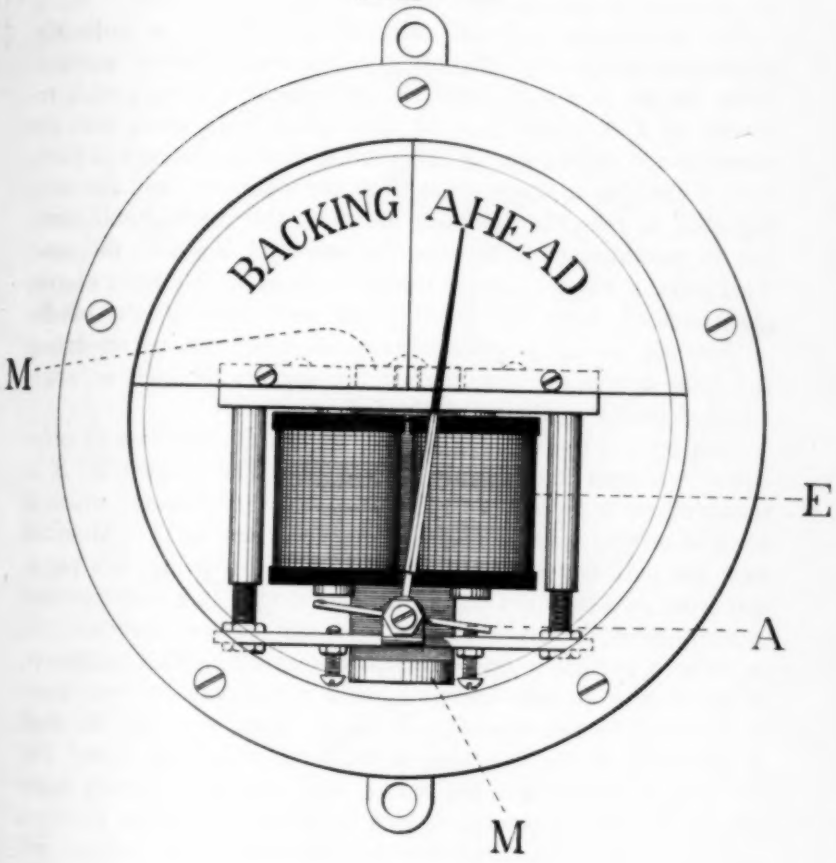
For making smaller adjustments, the rheostat box R may be mounted near the indicator G. This rheostat box is of the general type used in the range-indicator, and consists, broadly speaking, of a resistance wire wrapped around the surface of an insulating cylinder, so arranged that, by revolving the cylinder, a greater or less amount of resistance may be introduced in the circuit. This adjustment is not always used.

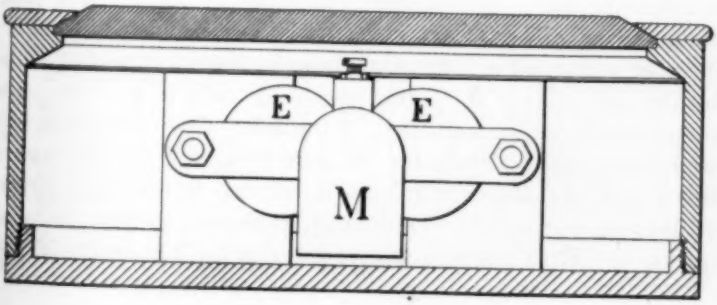
The graduations of the galvanometer G are made empirically in manufacture. A shaft carrying the inductors I is run at the various speeds, and the scale of the indicator G is marked with the proper numerals at the places at which the needle stands.

When the speed indicator is mounted on board ship the electrical apparatus of the indicator may be mounted in a water-tight case filled full of a liquid in order to steady the needle. Doubtless many different liquids may be used. Poppy-seed oil is satisfactory; but alcohol mixtures dissolve the shellac on the wire. The galvanometer case is filled from the top, by pouring the liquid through a sort of stand pipe P, Fig. 22, in which it stands at a height somewhat above the case itself. The filling hole

DIRECTION INDICATOR.

Fig. 21.





in the pipe is closed by a screw plug, and in this plug is a small hole, which allows the passage of air into or out of the pipe, as the liquid contracts with cold or expands with heat.

The alternating current galvanometer, which is ordinarily employed, is not very different from the direct current galvanometer shown in Fig. 6. But the permanent steel magnet is replaced by a stationary coil of wire which is in series with the movable coil or bobbin. Whenever the current changes in direction, it changes in direction in both the stationary and the moving coil, so that the direction in which the moving coil turns, due to mutual reaction between the two coils, is always the same. Two pairs of volute springs, similar to those in the direct current galvanometer, keep the moving coil, and therefore the needle, at a certain normal position of rest. But any current traversing the coils moves the coil against the springs through an angle which depends on the strength of the current.

That part of the apparatus which shows the direction of revolution is shown in Figs. 18, 20 and 21. The magnet N′ S′ is mounted on a projection, C″, secured to the band C′, which is secured on the shaft by means of lugs and screws D′. Mounted near the path traced by the poles N′ S′ in revolving, is a bar of soft iron, on which is a coil of wire connected to a direct current galvanometer, polarized relay, or other current indicator G′, in which a current in one direction causes the needle, or pointer, to move in a certain direction, while a contrary current causes it to move in the opposite direction. Suppose that the shaft is revolving in the direction of the hands of a watch, and that the pole S′ approaches the bar of soft iron until directly opposite to it. The approach of this pole will, of course, induce a current of a certain direction in the coil, which current will cause the needle, or pointer, to move, say, to the right, with a quick motion. As the shaft continues to revolve, the pole S′ leaves the bar of iron and the pole N′ comes up to it. This act induces in the coil a current opposite in direction to that induced by the approach of the south pole, and tends to give the needle, or pointer, a movement, say, to the left. The revolution of the shaft continuing, draws the N′ pole from the bar of iron, and this act induces another current in the coil in the same direction as did the approach of S′ pole, and, therefore, another movement of the needle, or pointer, say, to the right. The result is, there-

SPEED INDICATOR

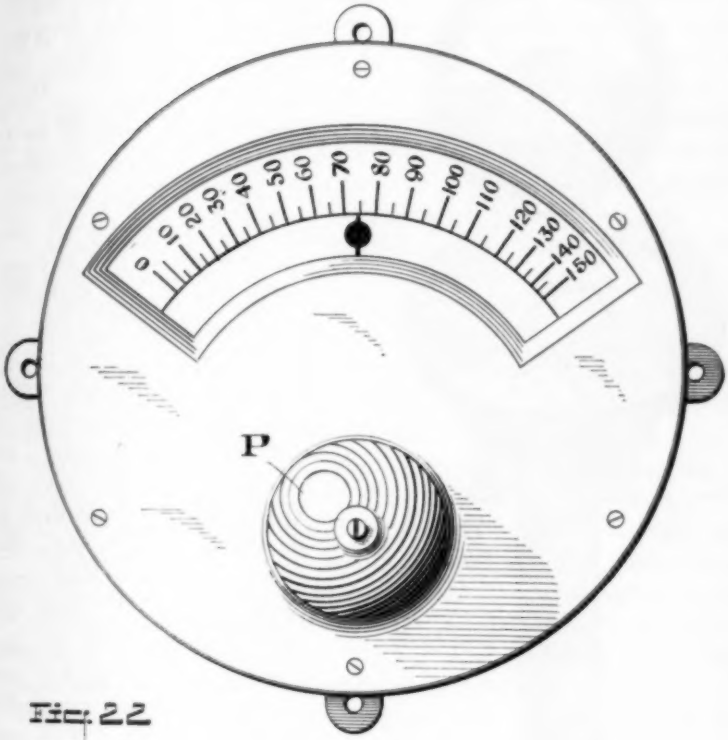


Fig. 22

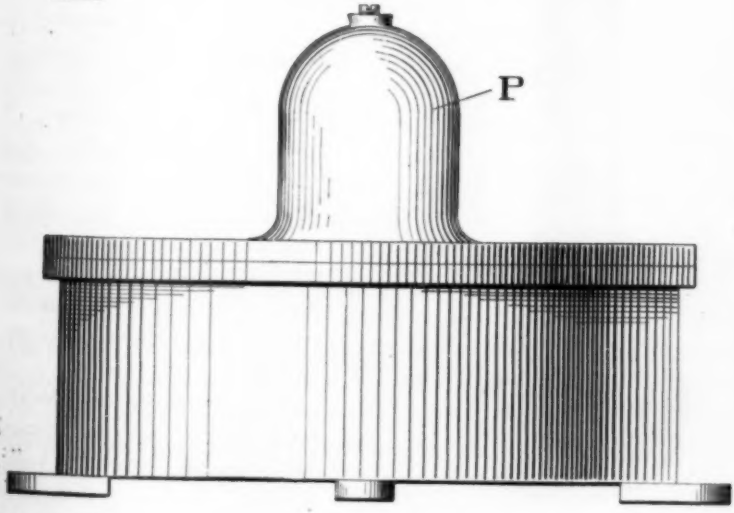


FIG. 22 A.

fore, that at every revolution of the shaft in the direction of the hands of a watch, the needle, or pointer, of the indicator gives quick movements, say, to the right, left, right. If the shaft is moving in the reverse direction, the state of affairs produced is just the reverse of that above cited; so that at every revolution of the shaft, the needle or pointer of the indicator makes quick movements, say, to the left, right, left. By merely looking at this indicator, therefore, an observer sees at once in which direction the shaft is revolving, and he sees also when each revolution takes place. Not only this, but the observer, when he has leisure, can count for one minute the movements of the needle or pointer of G′ and see what was the number of revolutions actually made in the minute. The direction indicator is, therefore, a speed indicator also, and may be used as such in case of accident to the direct reading instrument, in connection with which it may always be employed, moreover, as a means of verification.

Fig. 21 shows a "polarized relay," such as is used for ringing magneto bells, adapted as a direction indicator. The armature A, po-

larized, (magnetized) by the permanent magnet, M, is pivoted between the two poles of the electro-magnet E. The alternating currents generated pass through the coils of this electro-magnet and tend to give the armature successive movements right, left, right, or left, right, left, at each revolution. And since there is no directing spring on the armature, and since the magnetized armature when moved to either side tends to remain there, by reason of its nearness to one iron core or the other of the electro-magnet E, the armature remains during the whole time of a revolution, except when the magnet N′ S′ is actually passing the soft iron bar and its coil, at the position in which it was placed by the last current. In other words, the armature has a certain position of rest which it occupies throughout nearly the whole of a revolution, and which is the position in which it is placed by the last current of the three which are induced by the passage of the magnet N′ S′ in front of the soft iron bar and its coil.

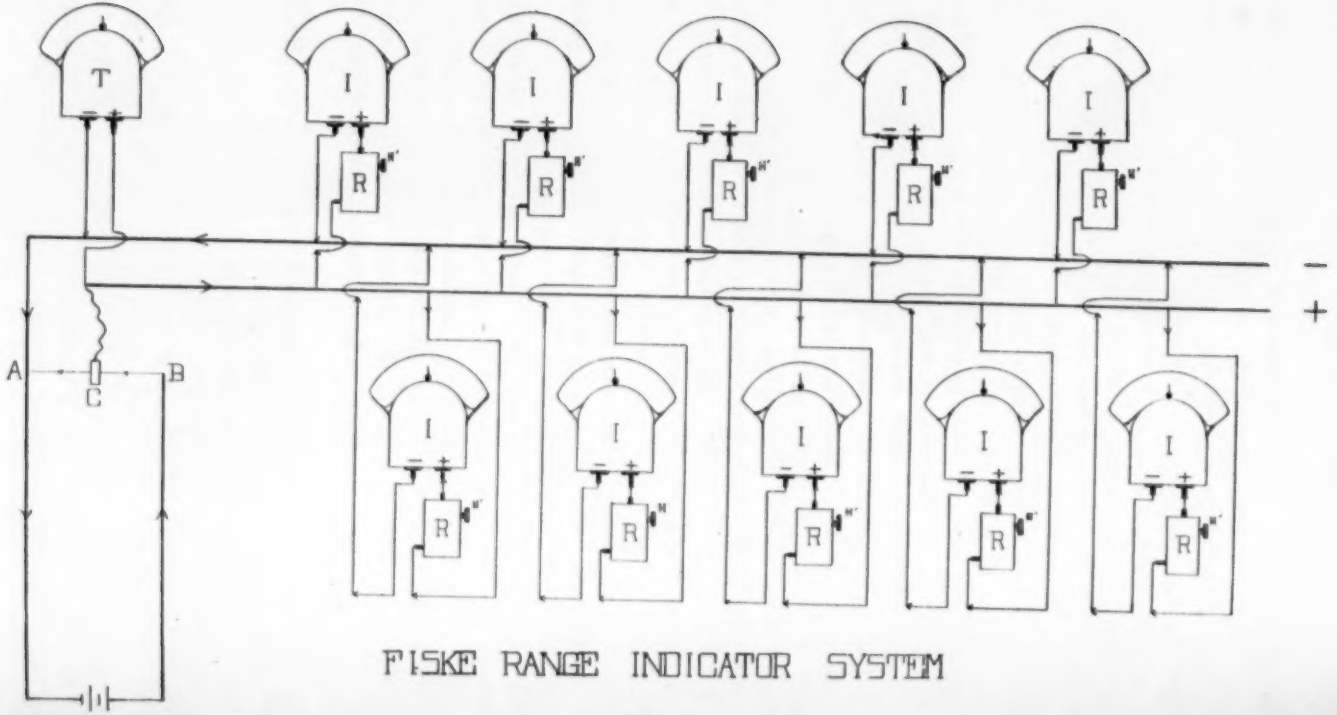
Furthermore, as the last current, when the shaft is going in one direction, is the reverse of what it is when the shaft is turning in the opposite direction, this position of rest is on one side or the other of its middle position, according as the shaft is going ahead or backing; and as the first current generated in any revolution is the same as was the last current, and as the armature cannot move any farther, the first motion cannot take place except during the first revolution of the shaft.

The result of all this is, that, if the shaft be going *ahead*, the pointer of the direction indicator, which is attached to the armature, will occupy a position of rest on one side of the scale and will make a quick motion to the left and back at each revolution; whereas, if the shaft is *backing*, the pointer will lie on the other side of the scale and will make a quick motion to the right and back at each revolution.

The two sides of the scale are marked "Ahead." and "Backing" respectively, as shown in Fig. 21.

The copper wires used in the circuits should not be less in size than No. 16 American gauge.

The speed indicator has been in successful operation on board the U. S. armored cruiser New York for about eleven months, and the direction indicator in the same ship for about six months. Both are now being installed in the battle-ship Texas, showing in the conning-tower the speed and direction of revo-



FISKE RANGE INDICATOR SYSTEM

FIG. 23.

lution of both engines; and they are to be installed in the Brooklyn.

Speed and Direction Indicator.—In case the permanent magnet of the speed indicator should in time lose so much of its magnetism as to need recharging, the recharging can be done by simply holding one pole against the pole of opposite name of a dynamo for, say, a minute, tapping the magnet smartly meanwhile, and then pulling it quickly away. In cases where more than one indicator of speed is desired for any shaft, it is safer to use a transmitter on the shaft for each indicator, in order that an accident to any indicator may not impair the efficiency of the others.

In the illustrations the magnet of the direction indicator is shown as projecting radially from the shaft. In many cases, however, it is more convenient to have the magnet lie parallel with the shaft or at an angle to it. The arrangement most convenient for installation and use must be the one used in each case; but the poles of the magnet should not be closer than two inches to the iron shaft.

The liquid for the speed indicator should be a thin vegetable oil which does not congeal readily. Poppy oil and oil of almonds are suitable, as they do not congeal until near 0° F.

For illuminating the scales of the speed and direction indicators, a small electric lamp is placed inside the direction indicator in such a position that it illuminates both scales. The light is turned on by pressing a water-tight push button on the back of the case.

Diameter of speed indicator = 7¼ inches.

Note.—The speed indicator works at its best when it is so placed that the half-way position of the needle is athwartships, and when the liquid is just thick enough to prevent the needle from vibrating when the propeller is racing. The direction indicator is important principally as a verification of the speed indicator, because it is so easy to change the adjustment of any transmitter in the engine-room, either from accident or for mischief. To open the direction indicator, unscrew the case.

Range Indicating System.

In the accompanying drawings, Fig. 23 is an electrical diagram illustrating the principle of the system, and showing one transmitting instrument T, and ten receiving instruments I, in circuit, each receiving instrument having an adjustable resistance in series with it, each adjustable resistance being in a metal box R. Fig. 24 shows in detail the mechanism by which in practice the contact C (Fig. 23) is moved along the resistance wire AB. Fig. 25 shows in detail the mechanism of the adjustable resistance inside of the box R; and Fig. 26 is a view of one of the receivers, or indicators, I (Fig. 23), with its resistance box R in position below it.

Referring first to Fig. 23, AB is part of a conducting circuit which includes the battery or other source of current, such as the electric light mains of a ship, connected through a suitable resistance, as shown in the cases of the helm indicator, steering telegraph and engine telegraph, in Figs. 1, 7, 10 and 11. T is a galvanometer which is connected in shunt with AB, one terminal being fixed at the point A, and the other terminal, or contact, C, being movable along the conductor AB. It will be clear that if the contact C is moved along the conductor AB, the difference of electric resistance, and, therefore, of electric potential or pressure between the points A and C will be varied; and consequently the extent of deflection of the needle or index of the galvanometer T may be controlled as desired, so as to cause said index to point to any scale-division or other mark or marks inscribed along its path. Connected in multiple arc with the galvanometer T are the two conductors + and —. Obviously these conductors will also be affected by the movement of the traveling contact C along the line AB, and will assume a difference in potential depending on the position of C on AB; so that if galvanometers I be connected to these conductors in the manner shown in Fig. 23, these galvanometers will respond to the movements of the contact C, for the same reason as does the galvanometer T. Furthermore, if all the galvanometers T and I be exactly similar, the needle deflections in all will be the same; and thus any indication caused in the galvanometer T will be repeated in the galvanometers I. Therefore, if T be the transmitting galvanometer, and if the instruments I be located at distant stations, it is plain that an operator at T, by adjusting the traveling contact C, can produce in his instrument a deflection which will instantly be repeated and shown at the distant stations in the receiving galvanometers I. It will be apparent, however, that if the galvanometers I are differently located with respect to each other and to the galvanometer T, so that in the circuit of one there is a different resistance from that which is in the circuit of the others; or if from any cause, such as rise in temperature, and consequent temporary loss of the magnet's strength, any galvanometer becomes less sensitive, means must be provided whereby said galvanometer may be adjusted or regulated so as to compensate for any such differences or changes, or, in other words, so that each receiving galvano-

meter may be so regulated that its deflections or indications will correspond to those of the transmitting galvanometer T. In the practical construction of the system these means are provided, and consist merely of an adjustable resistance placed in series with each galvanometer, and secured in a water-tight iron box R.

Turning now to Fig. 24, which shows in detail the means employed for moving the contact C along the wire AB, we see that the wire AB is wrapped in a spiral groove traced in an insulating cylinder D. The ends of the wire are secured to german silver springs, *g*, *g*, secured at the ends of the cylinder near the axis. The binding posts A and B are insulated from the metal box J, and their ends are prolonged about half an inch inside the box into cylindrical pins, or axles, *a*, *a*, which fit in the cylinder D, and press tight against the german silver springs, *g*, *g*, to which are secured the ends of the resistance wire AB. There is, therefore, a complete circuit from the binding post B to the german silver spring *g*, through the resistance wire that is wrapped around the cylinder, to the german silver spring *g* at the other end of the cylinder, and thence to the binding post A.

The cylinder is revolved on the axle AB by means of the handle H, which turns the screw S, and the gear wheel G, and thence the gear wheel G', which is secured to the cylinder D.

The contact C is secured to a stout piece of rubber that is secured on a nut N, that travels on the screw S. The pitch of the screw S and that of the spiral on the cylinder D are equal, so that, if the handle H be turned, the contact C will move with the nut N, though insulated from it, and press successively on different parts of the wire. The contact C is connected by the flexible wire W to the binding post C'. If the battery be connected to the binding posts AB, and if A and C be connected to the binding posts + and — of T in Fig. 23, it is clear that the act of revolving H will cause the same effect as if the contact C were directly moved along the straight wire AB, in Fig. 23.

Turning now to Fig. 25, which represents the adjustable resistance in the box R, we see that the construction is nearly the same as that in the transmitting box just described. The resistance wire is, however, connected to the german silver spring

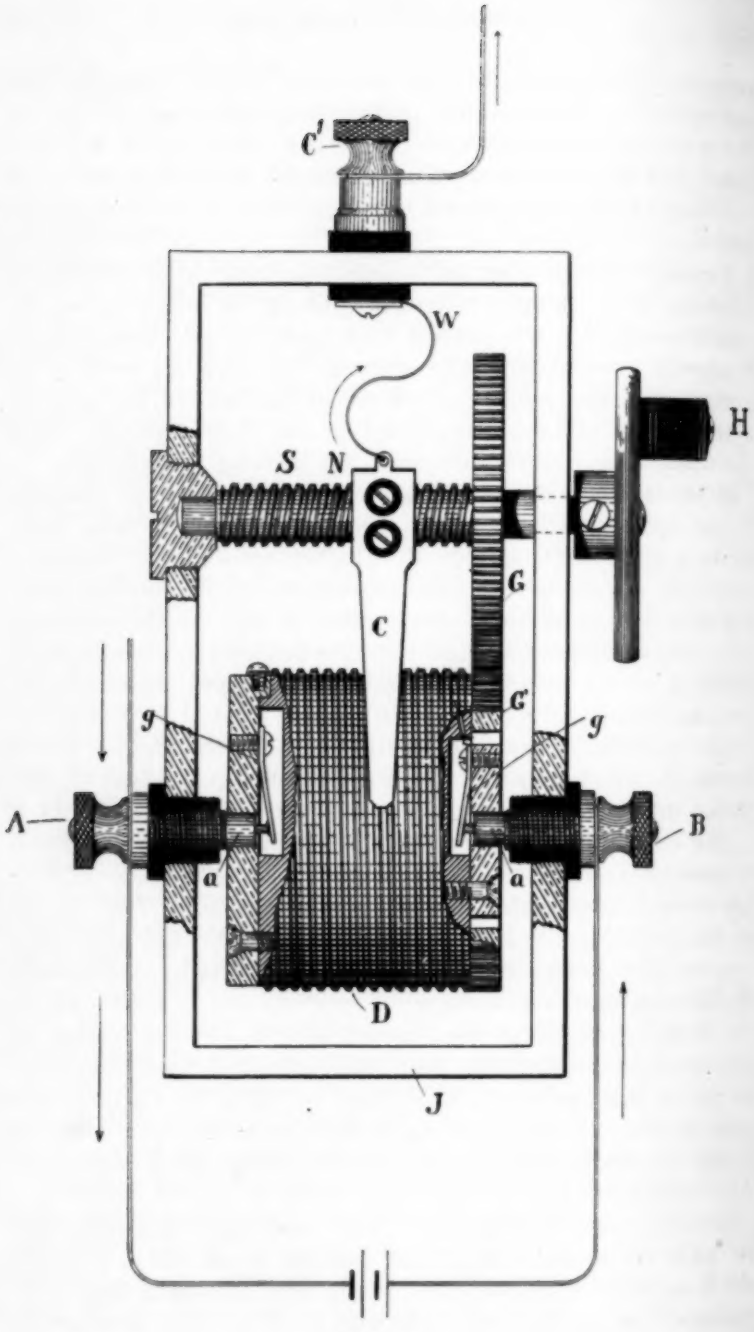


FIG. 24.

at the center of its cylinder at the left end only, as the right end of the wire is secured to the insulating cylinder at the point P. The contact C″ is moved in the same way as is C in the transmitting box, Fig. 24, and is connected by the flexible cord W′ to the binding post C‴. The current enters at the binding post A′, passes thence to the german silver spring at the left end of the cylinder, to the resistance wire wrapped on the cylinder, to the contact C″, and thence to the binding post C‴. Clearly, if this apparatus be placed in series with any galvanometer I, and the handle H′ be turned, the resistance in series with I will be varied and the deflection of I correspondingly changed.

The place for the transmitter T is near the reading instrument of the range-finder, so that any distance read from it can at once be made to appear on the transmitter and simultaneously on all the indicators in the ship.

To adjust the apparatus for use, connect the battery or other source of electricity and make the transmitter read, say, 2950, or any other preconcerted number. Then make each receiver read the same number, by turning the thumb wheel H′. The apparatus is now ready; but if there is time, it is best to try several preconcerted numbers in succession. It is better not to use the even hundreds in adjusting, because the graduations half-way between them are finer and give better opportunities for exactness.

The transmitting and indicating galvanometers are all similar, so that, in the event of accident to the transmitter, any receiver may be substituted for it. If this is done, however, it will be necessary, of course, to verify the adjustment of the instruments, in the manner above described.

In case a battery is used, the one found most satisfactory for all this class of work is the "chloride" storage battery. It is extremely uniform in resistance and in electro-motive force, and requires almost no care, provided it be connected to the electric light circuit and charged once a week. To do this is very easy, as it only takes a little more trouble than is required to turn on an incandescent electric light.

The galvanometers can be secured directly to a bulkhead. If desired, they can be graduated to work in a horizontal position.

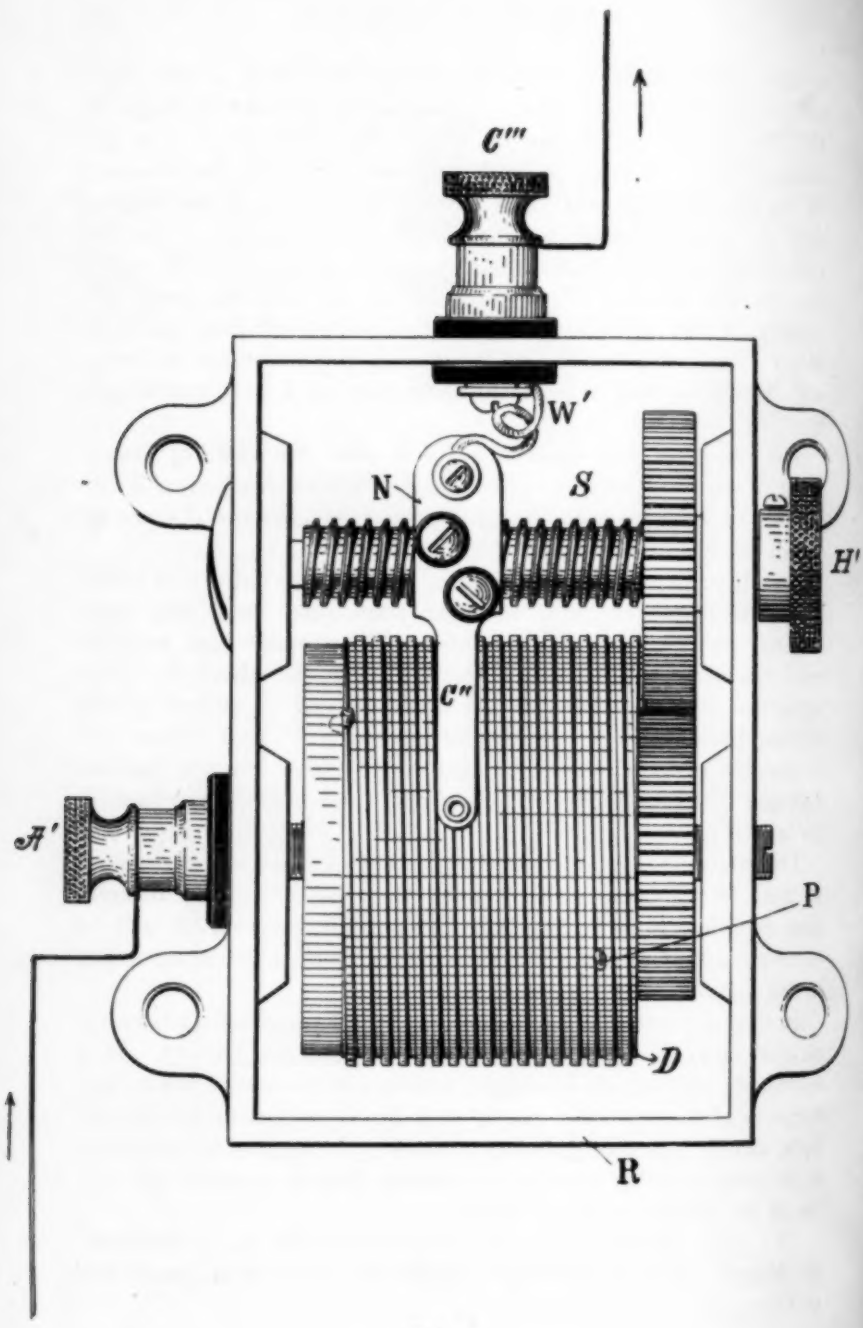


FIG. 25.

As far as giving accuracy of indications is concerned, the horizontal position is the best for a galvanometer, because the pivot of the needle is then vertical, so that the only friction possible is between the lower conical end of the pivot and the jewel in which it rests. From the circumstances of their use, the receivers must, as a rule, stand vertical; but there is no reason why the transmitters should not always be horizontal, both in service and when being graduated; and this is their proper position.

The later instruments are mounted in water-tight cases, and have the same construction as the instruments used in the helm indicator and steering-telegraph systems, illustrated in Figs. 6, 7 and 8.

Instead of being operated from a storage battery, as indicated in Fig. 23, the range-indicator circuit may be operated from the dynamo circuit, in the same manner as are the helm-indicator and steering-telegraph circuits; and the fact that the dynamo current is not uniform, but pulsating, is an advantage, because it gives the needles a minute vibration on their pivots, which is not sufficient to cause any difficulty in reading, but which prevents the needles from sticking.

The indicators should be so placed at the guns that they can easily be read by the gun captain, or other person charged with setting the sights, so that calling out by the voice will be avoided. A vertical position will, therefore, usually be best; and the indicators are graduated during manufacture while in that position. In case it is desired that one or more indicators shall lie horizontal, as may be the case in turrets, notice should be given in advance, in order that the indicators may be placed in that position during graduation. If the transmitter is placed below the protective deck, it should not, if it can be avoided, be put in a very hot place, because high heat diminishes temporarily the power of magnets, and this would render extra adjustment necessary on the transmitter.

The wires connecting the various instruments should have Navy standard insulation and be not less than No. 16 gauge. The mains should be laid, as far as possible, below the protective deck, with branches running up to each indicator, in order to minimize the chance of injury in battle.

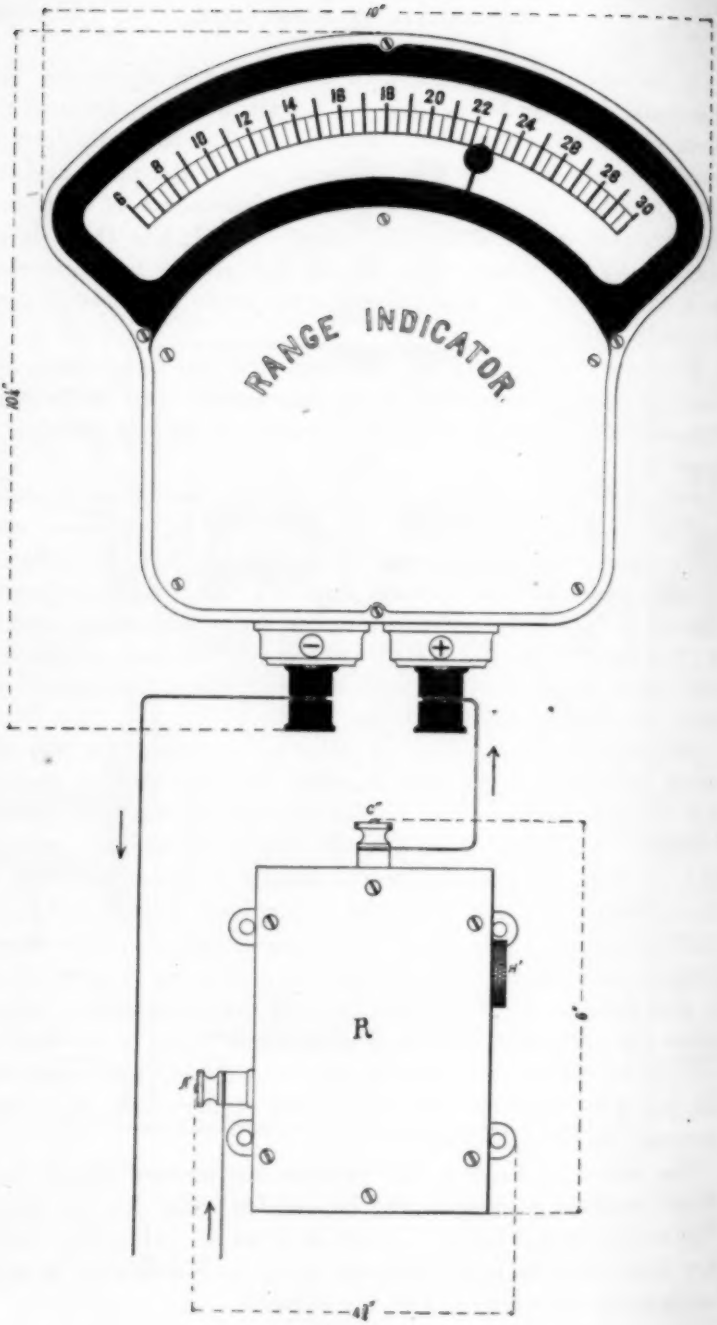


FIG. 26.

The rheostat which is placed in the dynamo circuit, for cutting down the current for the range indicators, should be of the Carpenter form, in order to economize space, and should, when the e. m. f. of the dynamo is 80 volts, measure about 50 ohms; so that, with the 3.7 ohms resistance of the transmitter coils the current in the coil will be about one and one-half ($1\frac{1}{2}$) amperes. The rheostat should be capable, therefore, of carrying $1\frac{1}{2}$ amperes without undue heating. It should be put in an accessible place in the dynamo room, where it can radiate heat readily, and for this reason should not be enclosed. Two separate wires are then to be run from the rheostat to the transmitter, so that the range indicator circuit will be independent of all parts of the lighting circuit, except in the dynamo itself.

The service trials held with instruments in the U. S. Flagship San Francisco for one year and subsequently in the U. S. S. Cincinnati for four months were satisfactory; and the system is now installed on a comprehensive scale in the battle-ships Maine, Texas, Indiana, Massachusetts, and Oregon, and is about to be installed in the armored cruiser Brooklyn and the battleship Iowa.

Resistance of each galvanometer, 60 ohms.

Weight of each galvanometer, 22 lbs.

Diameter of each galvanometer, 10 inches.

Resistance of each transmitter box about 3.7 ohms, the wire being 22 gauge.

Resistance of each receiving box about 17 ohms, the wire being 26 gauge.

Notes.—In the actual installation of the helm indicator and steering telegraph, each galvanometer of the helm indicator circuit is placed close to a galvanometer of the steering telegraph circuit; and both galvanometers are lighted from the electric light circuit and from the same rheostat, though in cases where the use of rheostats is inconvenient, small lamps using the full voltage of the light mains may be employed. In the case of the transmitter galvanometers of the steering telegraph and the receiving galvanometer of the helm indicator circuit, which are placed near them, the connections for their lights may be taken from the same rheostat as is used for the transmitters themselves, as shown in Figs. 7 and 8, the lights being connected to the binding posts *bc* and *cd* respectively.

The same arrangement may be used for connecting the range indicators to the electric-light mains of the ship, and for lighting them.

Regarding the external resistances for the helm indicator and engine telegraph circuits, which are preferably placed in series with the circuits, as shown in Figs. 1, 10 and 11, it is sometimes better to use two equal resistances instead of one for each circuit, one resistance being connected to the positive light main, and the other to the negative. The reason is that in many ships, the light mains are connected together through two lamps which are in series with each other, and the wire joining the two lamps is connected to ground, the arrangement forming a "ground detector." The two mains become thus forty volts above and forty volts below "ground" respectively (supposing the total voltage to be eighty). If, therefore, two equal rheostats are employed, the helm indicator and engine telegraph circuits themselves will never be more than about two volts from "ground," so that the chance of a "ground" in either circuit is extremely small. For the same reason it is better, in the case of the steering telegraph circuits, to connect the transmitters to binding posts *h f*, Figs. 7 and 8, which are about midway between the two ends of the rheostats and at nearly zero potential or "ground."

All of the ship telegraphs and their lamps can be run, if desired, direct from the electric-light mains of the ship without the introduction of any external resistance in their circuits, as it would be merely necessary to design them for the full voltage of the ship. But in view of the difficult conditions of ship life, especially in avoiding leaks and "grounds," it is thought that the low voltage system is the safest. The galvanometers may be made of convenient sizes for special installations.

If the radius of the wire of the transmitter of the helm indicator circuit is as great as 22 inches, the length of wire swept over by the traveling contact is sufficient to give the requisite deflection of the galvanometers, without using too great a current in the transmitter wire or too weak a spring in the galvanometers. It is safer, therefore, where the necessary space can be obtained, to use a radius not less than 22 inches.

Sticking of the Galvanometer Needles.—This is not likely where instruments are run from a dynamo current, because the fact that a dynamo current is not uniform, but pulsating, gives the needles a minute vibration, which shakes them on the pivots and antagonizes any tendency to settling at one position.

In case a galvanometer does stick, however, the sticking will be due probably to one of two causes: first, the needle may stick on its pivot; second, there may be a little dirt, specially iron filings, attracted by the magnet, between the moving bobbin and the poles of the magnet between which it moves. Either one of these contingencies is improbable, if the instruments have been carefully tested after installation and then closed tight. But in case the needle does stick, the second trouble is the more probable one. The best way to hunt for it is to take off the

cover of the instrument and hold an incandescent light so as to illuminate the interior, assisting the illumination by placing a sheet of white paper behind the moving coil. Any dirt can then be seen, and can be removed by a fine magnetized steel wire used as a probe. In case this annular space is clear, the difficulty will probably be in the pivot, and caused by the loosening of the little screws which adjust the pressure between the conical ends of the steel pivot and the agate bearings in which it rests at each end. The steel pivot ought to rest loosely, that is, not tightly, between its agate bearings; and the correct adjustment is made in manufacture and the adjusting screws are supposed to be set up tight, so as to prevent disadjustment. But in case the adjusting screws become loose, they must be reset. The only way is to tighten and loosen, carefully and by slow steps, until an adjustment is secured, such that the needle does not stick in any position.

Azimuth Telegraphs.

For telegraphing azimuths, or ranges varying between, say, 0 and 12,000 yards, for connecting position-finders to the gun, or relocator positions in forts, or for any other class of work in which many separate signals are required, the system is extended as indicated in Fig. 26, A. It simply amounts to using two transmitters and two receivers on separate circuits. One transmitter and its receiver are graduated in degrees, while the other transmitter and its receiver are graduated in minutes. Angles as high as 120 degrees can by this method be telegraphed with great quickness and extreme accuracy, that is, with errors of much less than one minute of arc.

For signaling ranges which must be correct within 1 yard, between 12,000 yards and 0, the same plan can be used, except that the 120 graduations of the left-hand galvanometer mean, not degrees, but hundreds of yards; while the divisions on the right-hand galvanometer mean, not minutes of arc, but single yards.

Besides the accuracy and quickness of this system of telegraphing, one important advantage is that the circuit is always closed, so that all the connections and contacts are always made, and there is no making and breaking of the circuit. All the connections may be made ten times as strong and big and firm as

is necessary, and even then they will not be very big, or take up much room; so that, if the system is kept in anything approaching good order, it will never break down in an emergency.

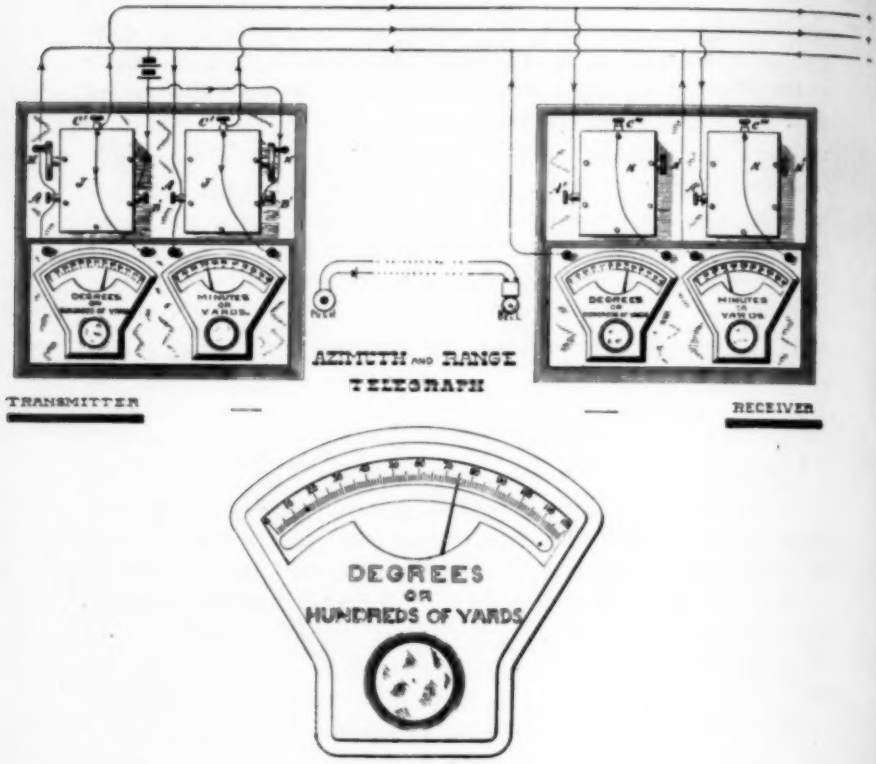


FIG. 26 A.

TRANSMITTER OF ORDERS.

The same system can be used to telegraph orders to the turrets, torpedo-positions, gun positions, and other parts of a ship, as it is merely necessary to graduate the dials of the indicators suitably, in some such way, for instance, as that shown in Fig. 26, B. The system is about to be tried in the U. S. armored cruiser Brooklyn, for transmitting battle orders from the conning-tower to the forward and after turrets, the dials indicating such orders as a captain would wish to give to the turrets in an action, when noise would make audible signals impossible.

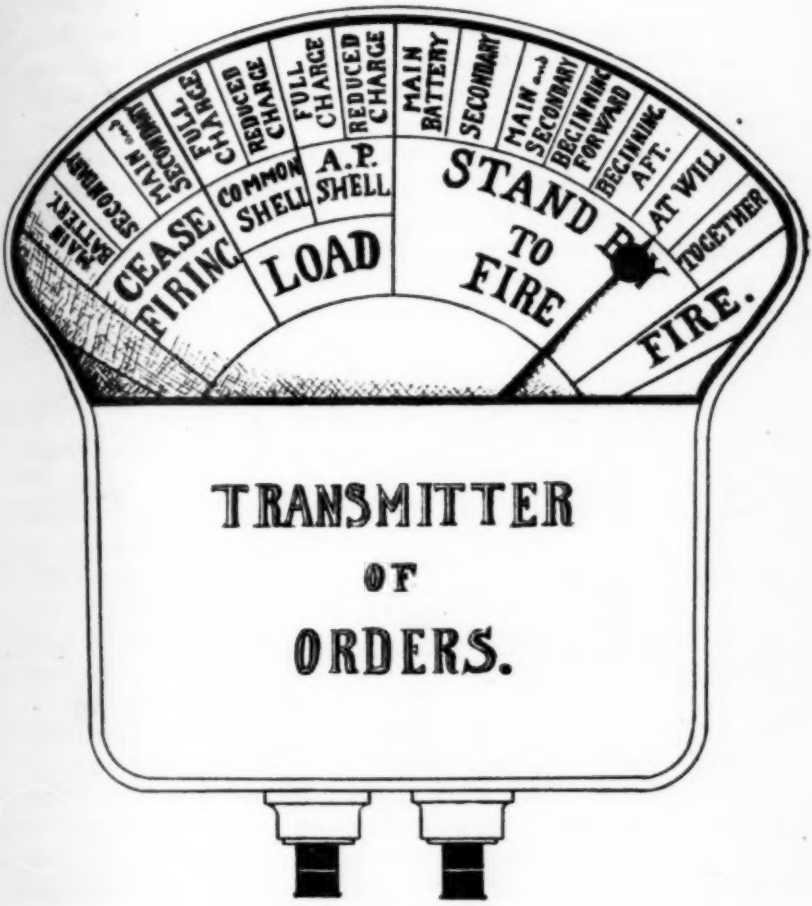


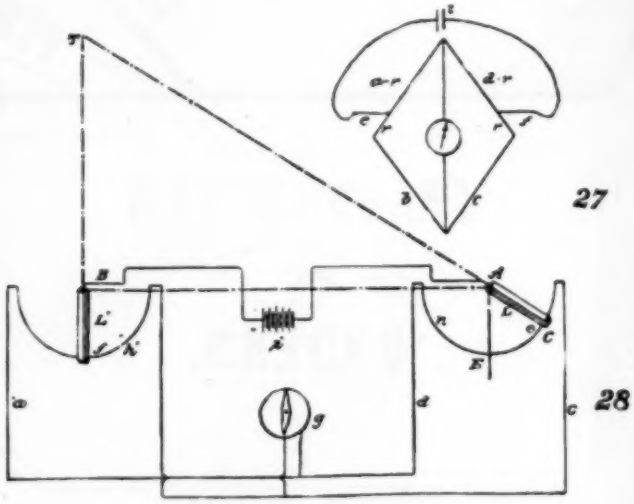
FIG. 26 B.

THE RANGE FINDER.

This instrument has now been tested for somewhat more than five years and has finally been adopted by the United States Navy. It has naturally undergone some changes during the process of evolution, and we now show the form which it has finally assumed. It will be remembered that the instrument is based, as far as the general principle goes, on the measurement

of resistances of a conductor, in the form of a Wheatstone bridge, there being two arcs of wire at the ends of a base line, each arc corresponding to two contiguous members of the bridge. Two telescopes are located at the ends of the base line and carry contacts which move over the wire as the telescopes are turned in angle, to be pointed upon any object.

Let Fig. 28 represent the arms *a* and *b* of a Wheatstone bridge bent into the form of an arc *h'*, while *c* and *d* are bent into the form of an arc *h*, both of these arcs being wires of conducting material. Let telescopes, pivoted at A and B, be fitted with the



FIGS. 27 AND 28.

contacts *e* and *f*. Now, if the extremities of the semicircular arcs are in the same line, the contacts carried by the telescopes will press on the middle parts of their respective arcs, and the galvanometer will, therefore, not deflect, whenever the telescopes are parallel and at right angles to the base line, because $ac = bd$. But when the telescopes are parallel they are directed at some point in space infinitely distant; that is, the distance of the object towards which the telescopes are directed is infinite. The position of rest of the galvanometer needle is therefore marked "Infinity."

Now, let the telescopes be directed at some point T not infi-

nitely distant. The telescopes will converge, and the angle of convergence is clearly the angle ATB, or the angle CAE, which is measured by the arc CE. In other words, the degree of convergence is measured by the difference in the positions of the contacts of the telescopes on their respective arcs. But, if the bridge was in balance when both contacts were at the middle points, it will clearly not be in balance when one is at the middle point of its arc and the other at C; and the amount by which it is out of balance will clearly vary with this difference of positions. That is, the greater the amount of convergence of the telescopes, the greater the deflection of the galvanometer; so that the deflection of the galvanometer varies with the angle ATB. By trigonometry,—

$$AT = \frac{AB}{\sin ATB} \times \sin ABT.$$

From this formula it is plain that, if ABT be a right angle, the distance AT varies inversely with the sine ATB; and it is, therefore, plain that, if the electro-motive force of the battery remains constant, the deflections of the galvanometer vary inversely with the distance; so that, if we know the length of base, we may graduate the galvanometer directly in units of distance, remembering that with such small angles as ATB always is in range-finding, the sine of the angle is practically the same as the arc.

But suppose that ABT is not a right angle. Suppose, first, that the target pointed at by the telescopes is infinitely distant, but in a direction inclined to the base. The contacts carried by the telescopes will not now press on the middle points of their arcs, but on points equally removed from the middle points. This is evidently the condition shown in Fig. 27, where the contacts have been moved away from the middle points over equal resistances. The galvanometer will not deflect, but will remain at its position of rest, which position on the galvanometer is marked "Infinity."

Let one contact be now moved from its position so that the telescopes converge and point at some object not infinitely distant. The galvanometer will deflect. In order to indicate the true distance of the object, the galvanometer must now deflect, not in proportion to sin ATB, but in proportion to ATB ÷ sin ABT. In other words, it must deflect more for an angle of

convergence ATB than if ABT were a right angle; and the smaller ABT is, the more the needle must deflect. In the range finder this increased movement of the needle is obtained by taking advantage of the curious fact that the current in the Wheatstone bridge increases as the contact points are moved away from the middle points. This is because the resistance

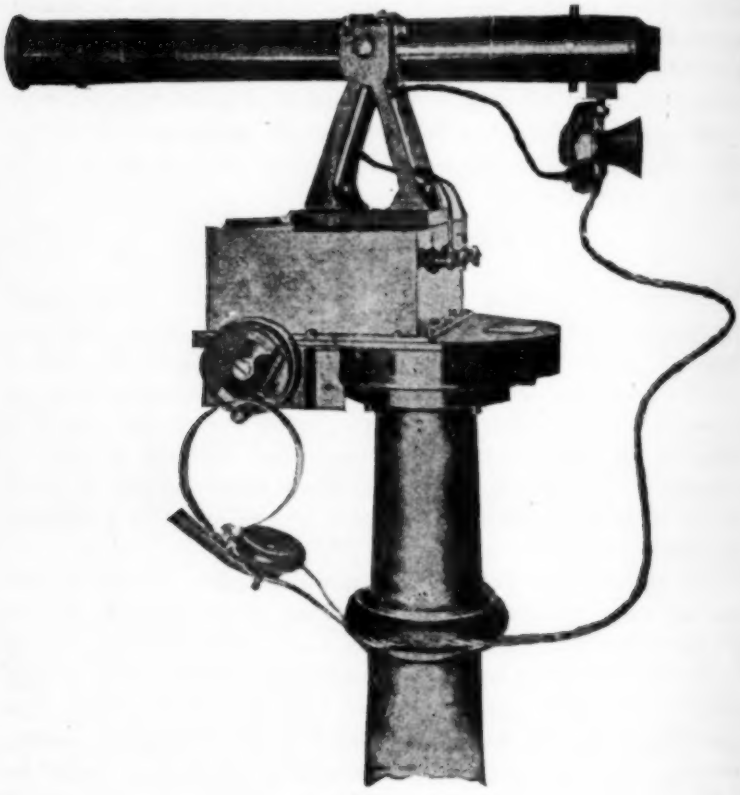


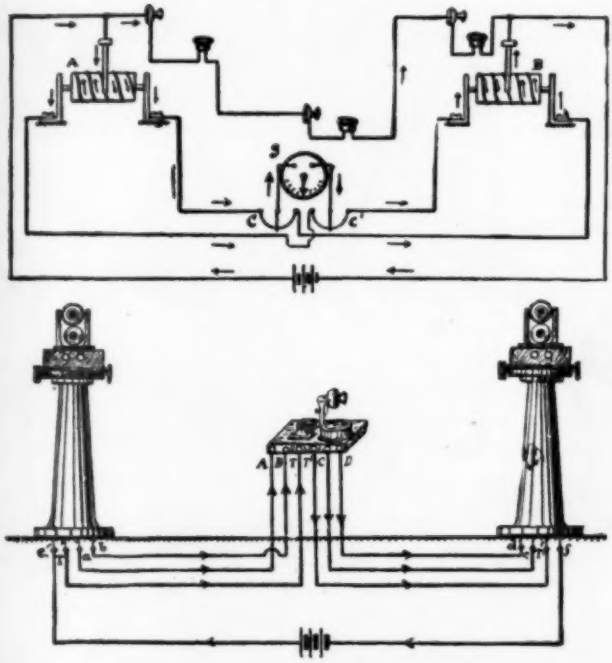
FIG. 29.

of the bridge is less; so that, if the electro-motive force of the battery is constant, the current increases proportionally as the resistance decreases.

In the apparatus as at present constructed, the wire is not laid in the form of an arc, but is wound upon a cylinder of insulating material. A contact presses on this wire, and as the telescope above shown in Fig. 29, is turned in azimuth, the insulating

cylinder revolves and causes the contact to press upon different parts of the wire. The special feature of value in this construction is that the wire is completely protected from the effects of weather, and, what is of more importance still, it makes it possible to use a device by which the non-uniformity of the wire is automatically corrected.

It has been said above that when the telescopes are parallel, and, therefore, pointing at some object infinitely distant, the contacts carried by the telescopes must press on the resistance



FIGS. 30 AND 31.—FISKE RANGE FINDER.

wires at similar points; so that the galvanometer needle will not move from the infinity mark no matter at what angle the telescopes are pointed. In order that this may be always the case, it is evident that we must have an exact equality in resistance per unit length of resistance wires, or else we must have some device by which non-uniformity will be corrected. This is accomplished in the instrument in question by a simple arrangement of the contact, by which, whenever the telescopes are

Fig. 32.

directed at similar angles, the contacts automatically go to such parts of the wire that the bridge is in balance and the galvanometer indicates infinity.

Another important feature introduced in the present apparatus is a temperature corrector, by means of which any change of temperature, either in the climatic or other conditions, and its consequent effect upon the resistance of the circuit, is automatically compensated. In Fig. 30 the temperature corrector is shown at C C′ and consists simply of two similar arcs of wire introduced in the circuit betweeen the two observing instruments at the ends of the base line, upon which arcs press the contacts of the galvanometer G. In case the temperature of either instrument, say B, is raised and its resistance correspondingly raised, it is simply necessary to move the two contacts of the galvanometer G along the arc C C′, a distance sufficient to compensate for the increased resistance of that instrument. In order to tell when this sufficient distance has been traversed it is merely necessary to set both instruments at similar angles and move the two contacts equally on C C′ until the galvanometer shows infinity.

This operation requires a few seconds only, and suffices to adjust the range finder for the temperature conditions which prevail that day. Fig. 31 shows a diagram of the circuit of the range finder. The two instruments at the opposite ends of the base line with their telescopes and telephones are shown. The arcs *a* and *b* of one instrument are connected to the arcs *c* and *d* of the other instrument, through the temperature corrector, which is mounted on the base of the reading instrument shown in the center. The telephones on the two observing instruments are connected together through the telephones on the reading instrument, and the battery contacts are connected to the storage battery, shown below, which is ordinarily in the dynamo room of the ship. On the same base with the temperature corrector is the galvanometer or reading instrument. The captain of the range-finder crew is stationed in the conning-tower of the vessel or below the protective deck at the reading instrument and has all the devices for correcting the range finder under his hand. He has simply to see what figure the needle of the galvanometer points at and telegraph this figure to the guns, by means of the electric range indicator.

The details of the reading instrument are shown in Fig. 32; and the interior of the galvanometer, which is the principal part of the reading instrument, is represented in Fig. 33.

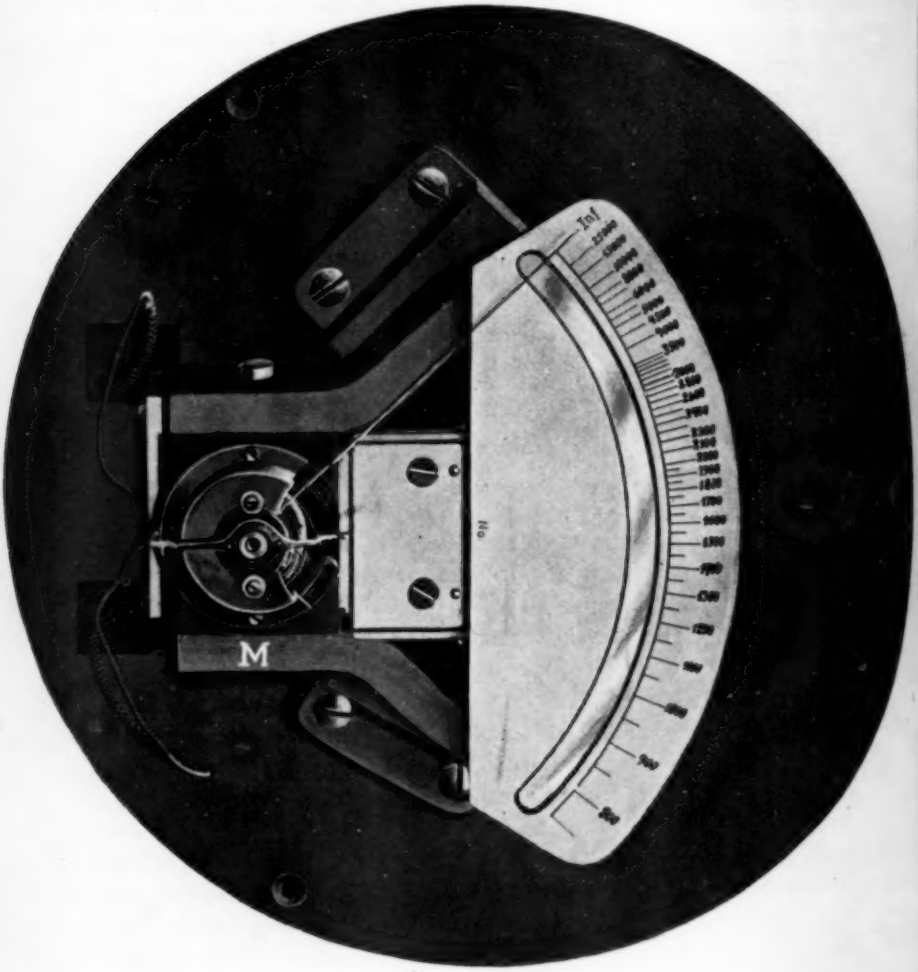


FIG. 33.

The shortest base lines with which this range finder has as yet been used successfully in practice, are in the New York and Indiana, in which the base lines are 46 and 44 yards respectively. In the Indiana, Massachusetts, Oregon, and Texas, the forward

observing instruments are mounted on a platform on the foremast, while the after instruments are at the after end of the superstructure. In the New York, both the observing instruments are on platforms on the masts; as is also the case in the Maine. In the other ships the observing instruments are usually secured on platforms built up from the deck, and on the conning-towers or pilot-houses. In most ships, the reading instrument and the transmitter of the range indicator circuit are in the conning-tower; but in the Maine they are below the protective deck, which seems a better arrangement in a military sense. It would seem advantageous also to protect the observing instruments to at least as great an extent as the rapid fire guns. The average error, under conditions of service, with base lines of 45 yards, is about 1 per cent. for distances of 1000 yards, 2 per cent. for distances of 2000 yards, 3 per cent. for 3000 yards, etc.

The Electric Telescope Sight.

At 2000 yards, a ship of twenty feet freeboard subtends a vertical angle of less than one-fifth ($\frac{1}{5}$) of a degree. The distance at which a gun captain stands behind his sights may be said to be about 120 inches from the front sight and 60 inches from the rear sight; so that this angle of $\frac{1}{5}$ degree is represented on the front sight by about $\frac{2}{3}$ of an inch, and on the rear sight by about $\frac{1}{3}$ of an inch. Now, in order to shoot correctly, the gun captain must fire so that the projectile will leave the gun just when the exact points of the two sights are in line with the target. It is not very easy to do this, as the records of gun practice at sea most sorrowfully prove.

A little reflection will show why correct firing is so difficult. In the first place, the construction of the ordinary bar sights is such that, unless the sights are on a level with the target in a vertical plane, it is extremely difficult to tell if they are pointed in the proper direction in a horizontal plane; and not only this, but when the ship is rolling away from the target, the rear sight and the gun itself mask the target completely; in the second place, the line of sight sweeps over the entire vertical target in $\frac{1}{5}$ of a second (supposing that the ship is rolling 1° per second, which is very slowly), so that the gun captain has only one-fifth ($\frac{1}{5}$) of a second of time in which to make up his

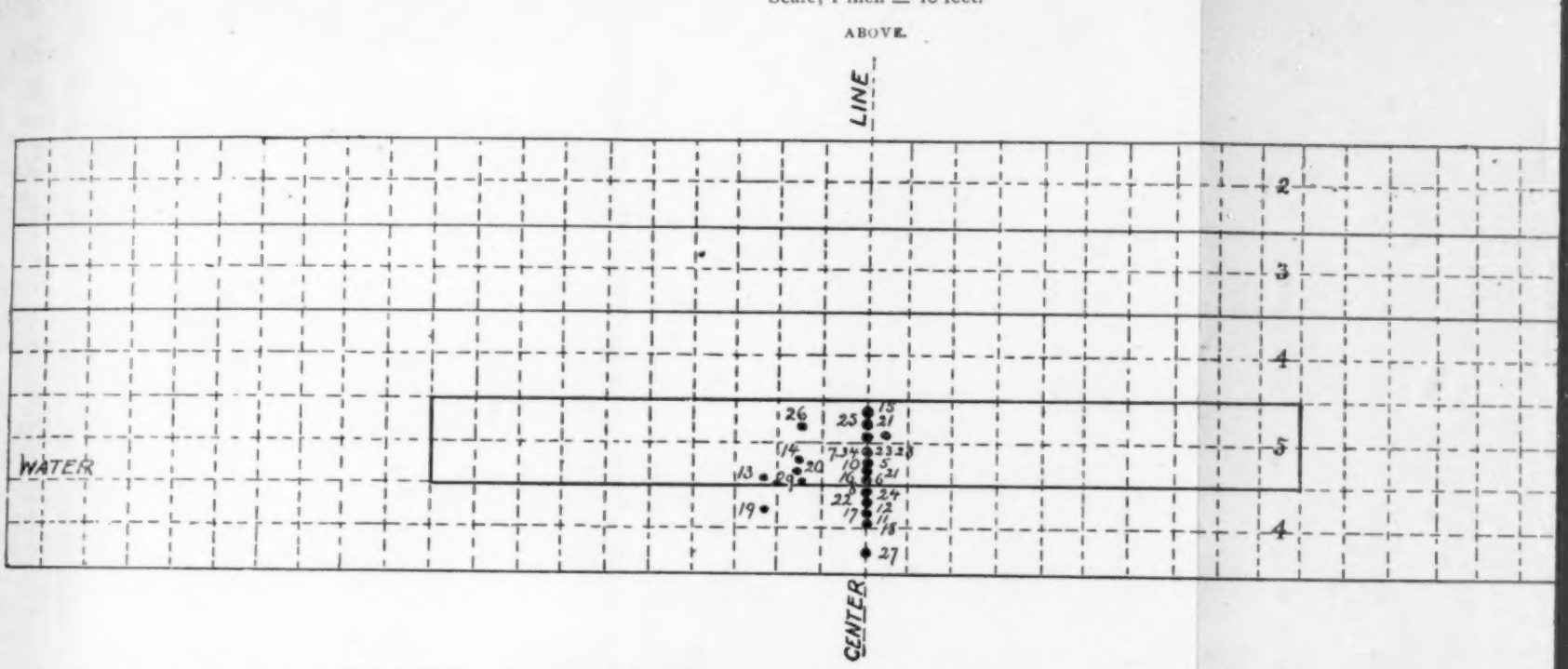
mind whether the sights are on the target, and to fire if they are on the target. Now the three objects which he is trying to get into line are the target, the front sight and the rear sight, of which one is 2000 yards distant, another about ten (10) feet, and the other about five (5) feet; so that he is called upon instantly to focus his eye on three points at distances of 2000 yards, 10 feet and 5 feet, and the human eye is so constructed as to make this impossible. But the formidable difficulty is that, during the one-fifth ($\frac{1}{5}$) of a second in which the gun captain must do the things above enumerated, he must, in addition, have the pupil of his eye behind the rear sight in an exact line with the line prolonged from the front sight to the rear sight. If the pupil of his eye is not exactly on this line he cannot recognize the instant to fire, except approximately, and if his eye be as much as $\frac{2}{3}$ of an inch above or below the line, and he fires when his front or his rear sight rests on the target, his gun will really be pointing 20 feet above or below the point of the target on which the sight rests. It is not an answer to point out the wonderfully fine shooting done by some men, because the records of target practice show that such shooting is, to say the least, exceptional. Now, a telescope of large field and small magnification has been found to practically eliminate all the errors of sighting, and to make it possible and easy for an ordinary man, with hardly any practice at all, to shoot fairly well always, and badly never, as was proved before an official board in the U. S. S. San Francisco, by the writer using in many cases absolutely untrained men, including firemen and coal-heavers. The result of the firing was plotted in the regular way, and is shown on plates A and B.

The large clear field of view with the two cross-wires, one vertical and the other horizontal, lets a gun captain see (even when the horizontal wire is far below or above the target) just how much the gun must be moved to the right or left; everything is exactly in focus, so that there is no strain on the eye whatever, and (which is the most important), the gun captain cannot sight wrong even if he tries. He cannot take a fine sight, or a coarse sight, or a bad sight. The cross-hairs are either plainly on the target, or plainly not on the target; and just so long as he looks through the telescope at all, he can see the cross-hairs in only one place, and that is in the fixed axis

Firing done with Hotchkiss 6-pdr. fitted with telescopic sight.

VERTICAL TARGET.—A.

Scale, 1 inch = 10 feet.



U. S. S. San Francisco—Captain J. C. Watson, U. S. N., Commanding.

Distance of target measured by Range Finder. C. W. Dilts, (App.) U. S. N. Observers, Ship —— —— ——. Right Boat, E. Packard, C. Q. M.

N. B.—29 shots were fired, each shot counted either 5 or 4. The deviation of the projectile to the right or left, as observed from the ship, was so small in each case measured with any means at hand; it was therefore estimated, using the known dimensions of the target as a reference.

PRACTICE (Stationary or Moving).

SHOTS FIRED.	GUNS, NUMBER AND CLASS.	NAME OF GUN CAPTAIN.	AVERAGE TIME BETWEEN SHOTS.	NUMBER OF GUNS FIRING.	LIMITS OF RANGE, YARDS.	MERIT OFF TARGET.	FINAL MERIT.
1–10	6-pdr. Hotch.	Lieut. Fiske.		1	1,000	100	
11–15	" "	Ensign Durell.			"	92	
16	" "	C. Leimbach, C. G. M.			"	100	
17	" "	A. Anderson, G. M.			"	80	
18	" "	J. Lang, Armorer.			"	80	
19–23	" "	Lieut. F. W. Kellogg.			"	96	
24	" "	M. Scanlon.			"	100	
25	" "	J. A. Gustafsen, Q. M.			"	100	
26	" "	T. Smith, Cox.			"	100	
27	" "	Capt. Kelton, U. S. M. C.			"	80	
28	" "	H. C. Witherbee, Cox.			"	100	
29	" "	W. Snodgrass, B. M.			"	100	

12)1128 = 94

Average of 12 men = 94. (9 of these men had never tried the sight before.)

DATE OF PRACTICE: May 7, 1894.

PLACE OF PRACTICE: Pearl Cay Lagoon, Nic

WIND AND WEATHER: Fine light breeze at r of fire.

SMOKE: Not troublesome.

ROLLING AND PITCHING: Rolling 1° each s slight.

VERTICAL TARGET.—A.

Scale, 1 inch = 10 feet.

nmanding.

(App.) U. S. N. Observers, Ship —— —— ——. Right Boat, E. Packar

The deviation of the projectile to the right or left, as observed from the ship
g the known dimensions of the target as a reference.

PRACTICE (Stationary or Moving).

AVERAGE TIME BETWEEN SHOTS.	NUMBER OF GUNS FIRING.	LIMITS OF RANGE, YARDS.	MERIT OFF TARGET.	FINAL MERIT.
	1	1,000	100	
		"	92	
		"	100	
		"	80	
		"	80	
		"	96	
		"	100	
		"	100	
		"	100	
		"	80	
		"	100	
		"	100	

12)1128 = 94

he sight before.)

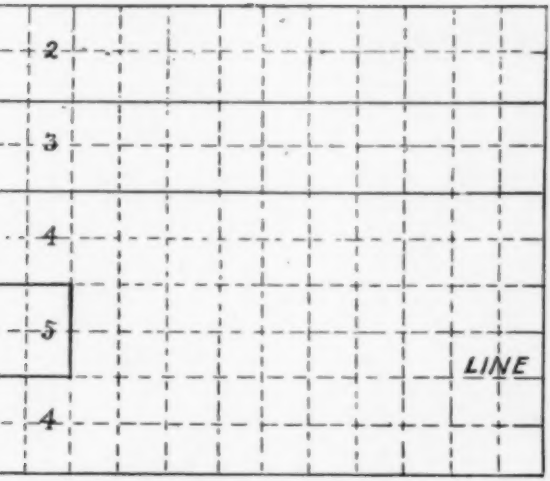
DATE OF PRACTICE

PLACE OF PRACTICE

WIND AND WEATHE
of fire.

SMOKE: Not trouble

ROLLING AND PITC
slight.



E. Packard, C. Q. M.
the ship, was so small in each case that it could not be

RACTICE:-May 7, 1894.

PRACTICE: Pearl Cay Lagoon, Nicaragua.

WEATHER: Fine light breeze at right angles to line e.

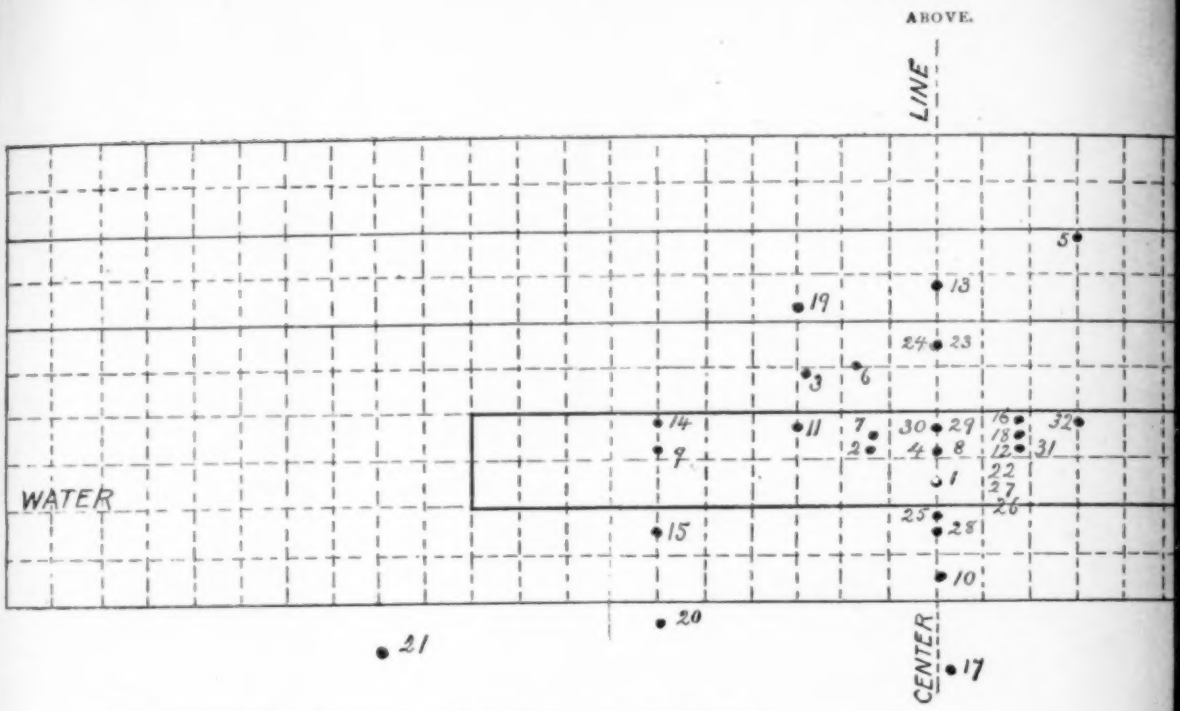
ot troublesome.

ND PITCHING: Rolling 1° each side, pitching very t.

Firing done with Hotchkiss 6 pdr. fitted with telescopic sight.

VERTICAL TARGET.—

Scale, 1 inch = 10 feet.



U. S. S. San Francisco—Captain J. C. Watson, U. S. N., Commanding.

Distance of target measured by Range Finder. C. W. Dilts, (Appr.) U. S. N. Observers, Ship —— —— ——.

The deviation of the projectile to the right or left, as observed from the ship, was in all cases, except that of th
hand; it was therefore estimated, using the known dimensions of the target as a reference.

PRACTICE (Stationary or Moving).

SHOTS FIRED.	GUNS, NUMBER AND CLASS.	NAME OF GUN CAPTAIN.	AVERAGE TIME BETWEEN SHOTS.	NUMBER OF GUNS FIRING.	LIMITS OF RANGE. YARDS.	MERIT OFF TARGET.	FINAL MERIT
1–4	6-pdr. Hotch.	H. J. Damm, App.		1	1,000	95	
5–8	" "	F. Smith, Cox.			"	85	
9–12	" "	C. L. Dooley, Lds.			"	95	
13–16	" "	L. Burke, Lds.			"	85	
17–20	" "	D. McCarthy, Sea.			"	40	
21–24	" "	John Dneefe, C. P.			"	65	
25–28	" "	C. Thorsoe, Mach.			"	90	
29–32	" "	P. Mullany, Boiler Maker.			"	100	

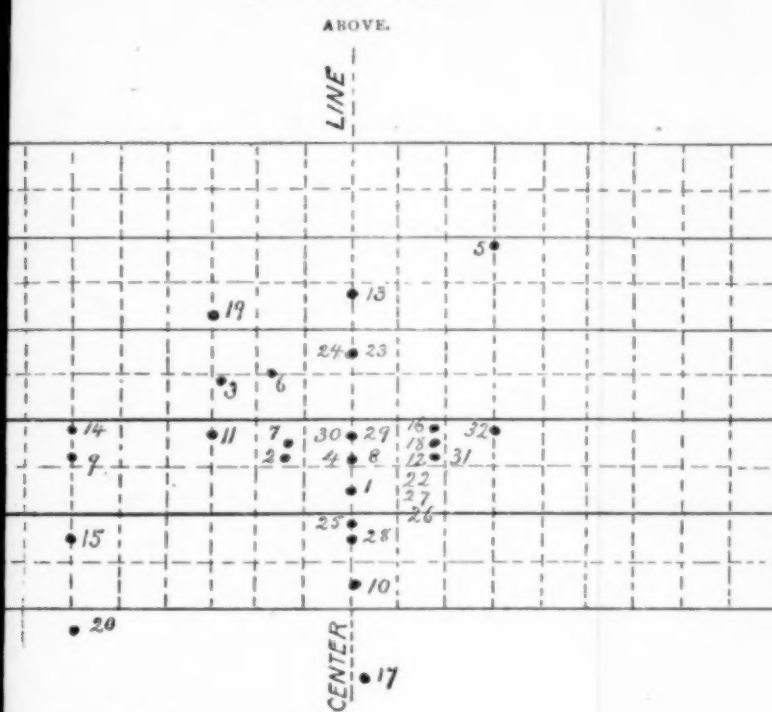
8)655 = 81.8

Average of 8 men = 81.8.

None of these men had ever used the sight before, except Smith, who had fired one shot the previous day. Dneefe and Mullany had made zeros on the last quarterly firing with muskets. Thorsoe had never before in his life, so he states, fired any kind of a gun, musket or pistol.

VERTICAL TARGET.—B.

Scale, 1 inch = 10 feet.



N., Commanding.

. Dilts, (Appr.) U. S. N. Observers, Ship —— —— ——. Right Boat, E. P

observed from the ship, was in all cases, except that of the shot No. 21, so st

ons of the target as a reference.

PRACTICE (Stationary or Moving).

	AVERAGE TIME BETWEEN SHOTS.	NUMBER OF GUNS FIRING.	LIMITS OF RANGE. YARDS.	MERIT OFF TARGET.	FINAL MERIT.
		1	1,000	95	
			"	85	
			"	95	
			"	85	
			"	40	
			"	65	
			"	90	
			"	100	
				8)655 = 81.8	

DATE OF PR

PLACE OF PR

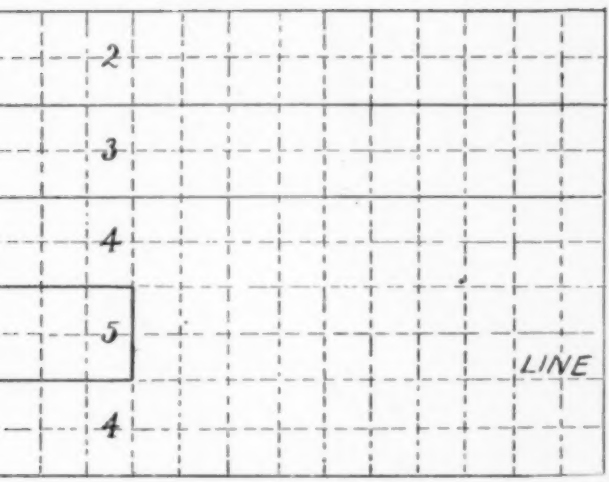
WIND AND W
of fire.

SMOKE: Not

ROLLING AND
slightly

, except Smith, who had fired one shot the previous day.

firing with muskets. Thorsoe had never before in his life,



oat, E. Packard, C. Q. M.
. 21, so small that it could not be measured with any means at

E OF PRACTICE: May 8, 1894.

E OF PRACTICE: Bluefields, Nicaragua.

D AND WEATHER: Fine gentle breeze at right angles to line of fire.

KE: Not troublesome.

ING AND PITCHING: 1° to 2° each side, pitching very slightly.

of collimation of the telescope. Since a telescope can be made to endure about as much rough usage as a football, it is surprising that any sights except telescope sights are used in modern ships. Of course they cannot be used on the guns themselves, because the guns recoil, but they can be placed on some non-recoiling part of the gun-support laterally moveable with the gun. The latest form of telescope sight has a field of view of 19° in each direction, with a magnification of about two (2) diameters, and is so strong as to be less liable to injury in service than is the ordinary long bar sight; so it can be kept in place all the time, ready for instant use. In order "to make assurance doubly sure," a strong sheet-iron cover thoroughly japanned is arranged to cover the sight when it is not in use.

A ship which can adjust her gun sights quickly, when the range is changing quickly, will have a great tactical advantage over a ship which cannot. It has been found, in practice, when the range is changing rapidly, that the range finder and range indicator can measure and signal ranges so rapidly that it is impossible to set the sights and get ready to fire before a new range necessitates a new adjustment of the sight. To secure the tactical advantage to be obtained by meeting this difficulty, the electric telescope sight has been devised to so work in co-operation with the range indicator, that the setting of the sight occupies but an instant, and does not interfere with the firing of the gun, or distract the attention of the gun captain.

As shown in Fig. 34, one of the receivers of the range indicator circuit is placed alongside of a similar indicator, which shows the distance corresponding to the angle between the bore of the gun and the line of sight of the telescope, placed in the sighting hood above the gun. Evidently the telescope and the guns are converged at the correct angle when the indicators indicate the same distance.

The operation is as follows: The gun-firer places his telescope at whatever position in the vertical plane he finds convenient. He does not need to know the range, except approximately.

The elevator man watches both the range indicator and the gun elevation indicator, and merely works the elevating mechanism so as to make the latter read the same as the former.

When the gun-firer sees his cross-hairs rest on the target, he presses the electric firing button.

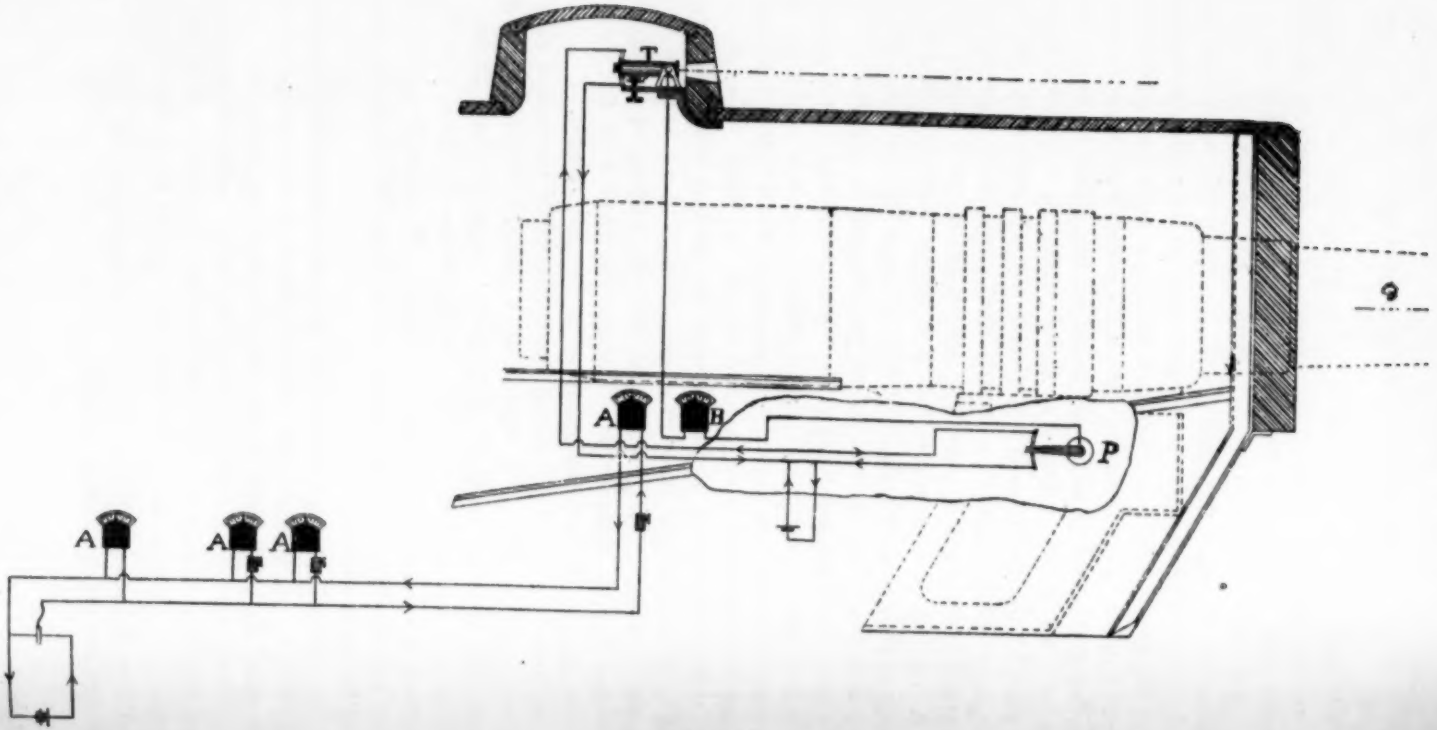


FIG. 34.

To prevent his firing when the indicators indicate differently, the firing circuit is broken at two places—one place being his firing key and the other place being a similar key near the elevator man. The gun cannot be fired unless both the elevator man and the gun-firer press their keys; and neither presses his key

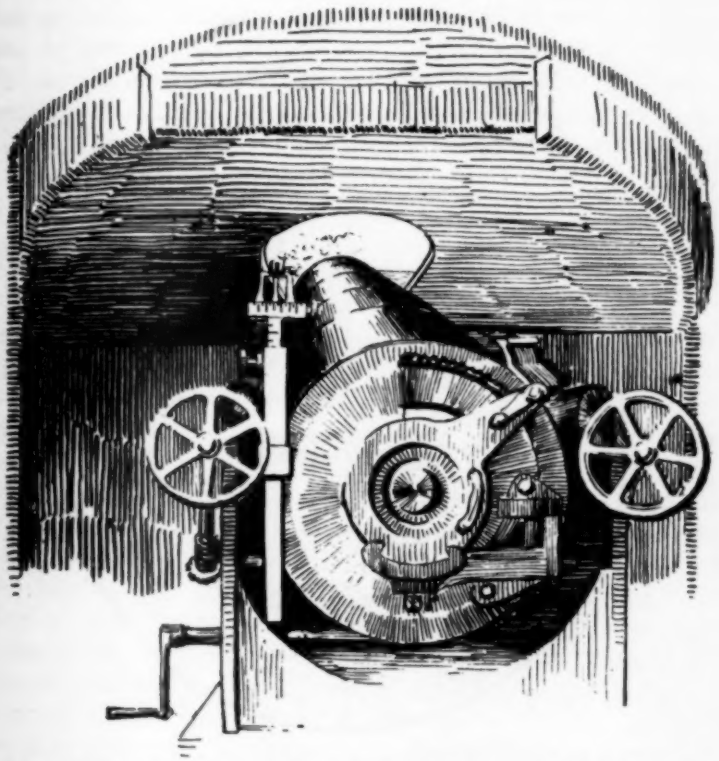


FIG. 35.—A BATTLE-SHIP 300 FEET LONG, MASTS 150 FEET HIGH, SEEN OVER ORDINARY GUN SIGHT AND THROUGH PORT IN GUN SHIELD.

Horizontal field in gun port=9.5°. Vertical field=3°. Eye of gun captain being 60 inches behind rear sight. Ship is 2,000 yards distant.

unless he is ready. The elevator man keeps pressing his key so long as the two indicators indicate the same thing; but, if the range suddenly changes, he releases his pressure on the key until by moving the elevator wheel he has made the gun elevation indicator indicate the correct distance; he does the same thing, if the gun-firer changes the position of his telescope and the indi-

cation of the gun elevation indicator. It will be noticed that this operation on the part of the elevator man is a very simple one, since he merely has to move his wheel a fraction of a revolution in one way or the other, to keep the needle of his indicator at the same mark as is the needle of the range indicator beside it.

On the base of the telescope sight are arrangements for correcting for speed and drift. The electric sight has not yet been tested in service, but it is merely a combination of the mechanical telescope sight with a simplified form of the helm indicator and steering telegraph.

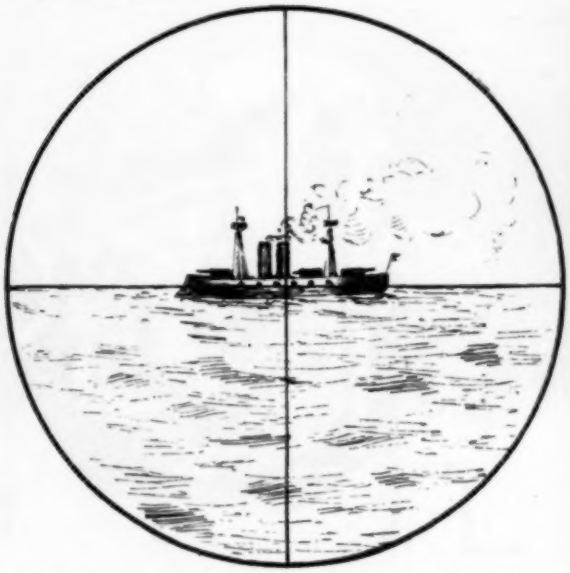


FIG. 36.—SAME SHIP SEEN, AT SAME DISTANCE, THROUGH TELESCOPIC GUN SIGHT.

Horizontal field=8°. Vertical field=8°. Magnification, 4 d ameters.

MECHANICAL TELESCOPE SIGHT.

In the case of guns that recoil along the line of fire, especially with the smaller calibers, the telescope sight is attached directly to the support of the gun, which moves laterally and vertically with the gun, but does not recoil.

Fig. 36 shows the field of view of the telescope sight which the writer mounted on the support of a rapid-fire gun on board

the Yorktown in 1892, and afterwards in the U. S. S. San Francisco in 1893 and 1894, the gun being frequently fired in both ships to test the sight. Fig. 35 shows, in comparison and on the same scale, the field of view obtained looking through the port in the gun shield, when using the ordinary sights on a 6-inch gun, in the Yorktown, on the shield of which the sight was first tested.

Position Finders.

While the appliances of modern warfare conspire to remove practical naval gunnery from the realms of chance to those of certainty, the art of coast defense is keeping pace, and is replying with every kind of thinkable device for increasing the rapidity and precision of fire of forts, *i. e.* for sinking attacking ships. Secured on firm emplacements, behind impenetrable walls, the guns and mortars of modern fortresses present the highest example of the combination of tremendous strength with refined precision. For the large calibers, the use of disappearing guns is on the increase, the gun disappearing behind the parapet after firing, to get a new charge. In order that the gun may be exposed above the parapet as short a time as possible, it is elevated on its carriage in accordance with the range signaled, and is trained in azimuth, according to the direction signaled, before it is raised to fire, so that as soon as it is raised it can be immediately fired, and then by the energy of the recoil forced back at once to the loading position. Now, the determining of this range and direction is the office of a position finder. The simplest kind is the "depression position finder." Of this type there are a very great number on instruments in use in Europe, the most successful being that of Colonel Watkin, of which the English Government keeps the details a secret. In this country, that of Lieut. I. N. Lewis, United States Artillery, has proved extremely successful. It is not electric, however, and so a description would hardly belong here. The writer has endeavored to accomplish both the work of measuring and of signaling the results in instruments of this class by means similar to those employed in the range finder, in the manner hereinafter shown.

It may be pointed out here that if the position finder simply finds the distance and direction of the target from the position finder at a given instant, the people at the guns will not be

benefited much, for two reasons: first, by the time that the gun can be gotten ready in accordance with any range and direction signaled, the range and direction will have changed; second, the people at the guns want to know the distance and direction of the target from their guns and not from the position finder. To remedy the first difficulty the people at the position finder do not signal to the guns what the range and direction are at that instant, but they predict what they will be thirty seconds later, so that the gun people have thirty seconds in which to lay the gun. To enable the position-finder people to predict they take observations every twenty seconds, plot the exact position of the target each time on the plotting table of the position finder, and connect the various points by a line, more or less broken. A little practice enables them to thus lay down on the chart the exact track a ship is making. If the track shows that the ship has gone a certain distance in a certain direction in a certain time, it is not hard to prolong the track line so as to show where she will be two minutes later; in other words, to "predict her position." It is this predicted position that is signaled to the guns. When the ship arrives at or sufficiently near the predicted position, the signal is sent to the guns to fire. Of course if during the interval the ship suddenly changes her course and speed very greatly, she will not reach the predicted position at exactly the end of two minutes. But a heavy ship cannot alter her course and speed so much in two minutes as to throw out the predicted position much, as even a rough calculation will show, especially if she is in company with other ships in a channel; and even if she could, it would be simply necessary to hold the fire until a new position were determined, which would be a matter of a few seconds only. The manner of using the position finder can be best shown by an extract from the official report on one placed at Spezia, Italy.

The disposition of the Fiske position finder renders it possible to make rapidly a series of observations upon a target in motion, and to solve the problem of how she is going; to determine the route, the radius of the circle of turning, the speed, etc. During the recent trial at Spezia, the base line of the position finder being 104 meters long, there was determined the velocity of a torpedo-boat which was going at a speed of 8 knots, of 10 knots, of 12 knots, maintaining a distance from the position finder ranging from 2000 meters to 5000 meters. There was determined at regular intervals the different points of her track, and the

resulting speed deduced varied from the speed obtained on board the vessel itself by only 3 per cent. In order to give an idea of the quickness with which it is possible to fix the ship's position, and after the observers have had a certain amount of practice, it is sufficient to cite the fact that while the torpedo-boat was making a complete circle of 250 meters diameter at a speed of 10.5 knots, the average distance from the position finder being 1500 meters, there were plotted 11 successive positions. In another trial, while the boat was making a circle of 350 meters diameter, at a distance of 2500 meters from the position finder, at the same speed her position was plotted 17 times.

The position finder having determined the range and direction of the target from itself, it remains for the people at each gun to determine what are the range and direction from that gun. This may be done by means of tables of figures, which show for each gun what are the directions and ranges from that gun of every position that can be signaled from the position finder. But a speedier plan is offered by the instrument invented by Lieutenant Rafferty, United States Artillery, called a "relocator," in which the conversion from one system of co-ordinates to the other is done mechanically. The instrument is extremely simple in construction, and (which is more important) is simple in operation, but not being electrical, its description hardly belongs here.

Depression Position Finder.

When the ground in the vicinity of the water is high, the distance of a vessel on the water can be found very simply by mounting a telescope on an eminence, pointing it at the vessel's water line, and noting the angle of depression of the telescope below the horizontal. The height being known, the distance is inversely proportional to the sine of this angle, so that the instrument may be graduated at once in yards. The direction is obtained with equal simplicity, by noting the azimuth of the telescope, as shown on a horizontal circle. To make these measurements and send them to the guns automatically is the office of the instrument hereinafter described. Corrections are, of course, needed for the rise and fall of the tide and for changes in refraction. The special limitation of this class of apparatus is the fact that the smoke of guns frequently hides a vessel's water line altogether, as was conspicuously shown at the battle of the Yalu.

The apparatus consists in two principal parts, namely, a device for determining the distance and a device for determining the direction or bearing of the object. The said two parts are used conjointly, and thereby the location of the object may be recognized upon a chart representing the area of the harbor, for example, drawn on a reduced scale.

In the accompanying drawings, Fig. 38 is a diagram illustrating the operation of the distance or range finder. Fig. 37 is a diagram illustrating the operation both of the range finder and of that part of the apparatus which shows the bearing of the distant object. Fig. 39 is a side elevation of the observer's instrument and shows the mechanism thereof on a larger scale and in detail.

Similar letters of reference indicate like parts.

Referring first to Fig. 38, A is a telescope, sight bar, or other like means of directing the line of sight, indicated by the dotted line upon the object B. This telescope is to be located upon an elevation adjacent to the waterway to be protected. The telescope is pivoted at its outer end, so that it can be depressed through any desired angle in order to bring it to bear upon the object. The telescope is provided near its sight end with a contact piece or wiper which always bears upon a body of conducting material, represented symbolically at C. Connected with the ends of the body C is a voltaic battery, D, and connected in circuit with one end, E, of the body, C, and with the movable wiper or contact piece carried by the telescope A is a galvanometer, F. It will be apparent that as the telescope A is moved on its pivot its contact piece or wiper will be carried along the body C, and, as a consequence, a greater or less amount of the body C will be brought into the circuit which includes the galvanometer F. Inasmuch as the body C is to be constructed of, for example, a wire of uniform resistance per unit of length, it is obvious that as the telescope A is moved and a greater or less length of said wire is brought into the galvanometer circuit, the resistance thus interposed in said circuit will be increased or diminished; and as this length, and hence this resistance, depend upon the angle of depression of the telescope, it becomes a function of the angle of depression; and, equally, the deflection of the galvanometer F, due to this change, is also a function of the angle of depression. Therefore, knowing the

FIG. 37.—POSITION FINDER.

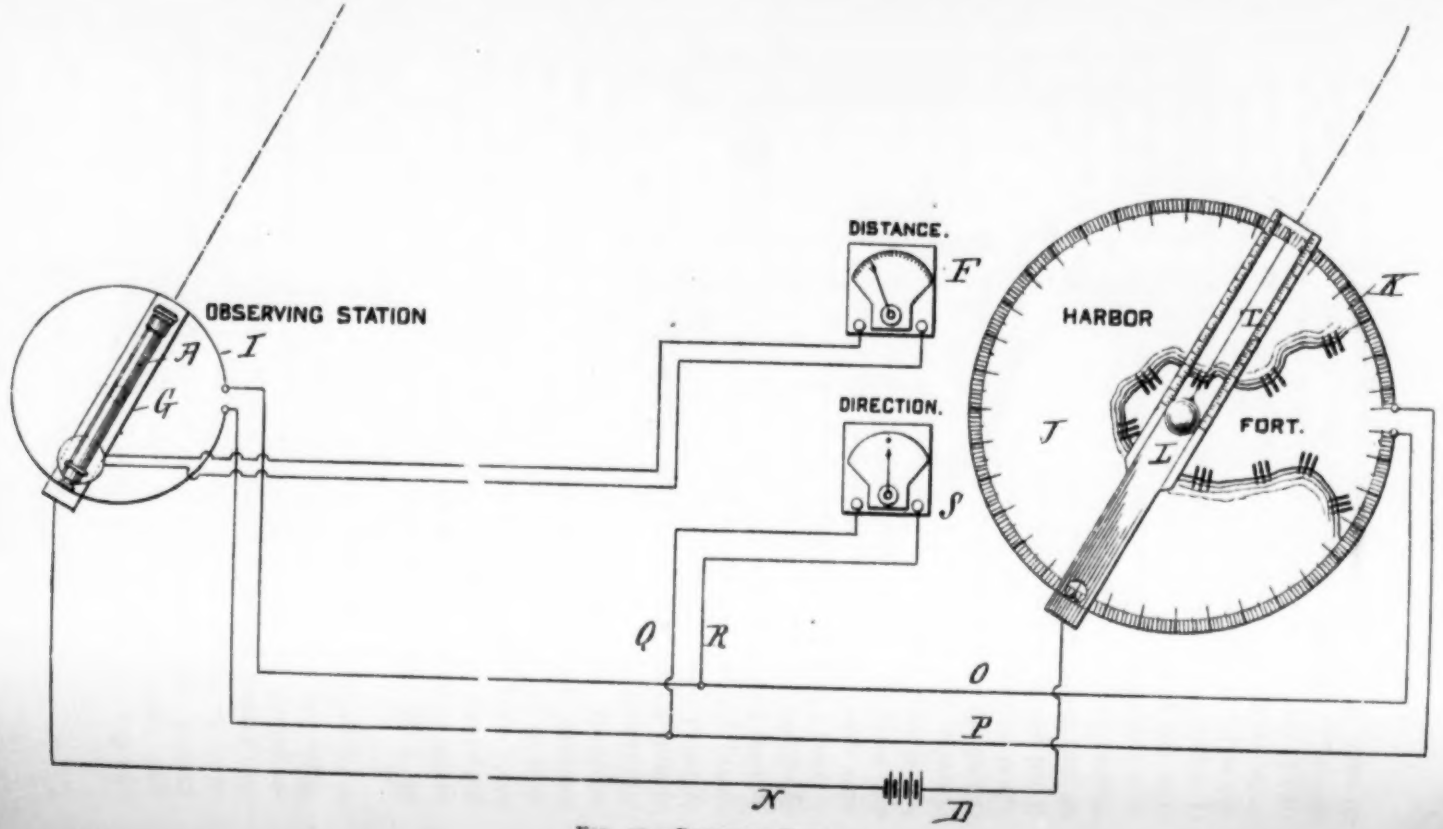


FIG. 37.—POSITION FINDER.

height of the telescope above the level of the object, the galvanometer deflection will indicate the distance of the object from the telescope, for which purpose the galvanometer may be once for all graduated in any suitable unit, such as meters or yards. Hence, if the galvanometer be located at a station distant from that telescope, an observer at that distant station, by reading the galvanometer, can recognize at once the distance of the object, while the person stationed at the telescope has nothing to do but to keep it properly directed upon the object.

The telescope pivot is carried upon a bar G, Fig. 39, which is pivoted upon a circular table, H. Placed in a groove around the periphery of this table is a wire I, Fig. 37, of conducting material, having a uniform resistance per unit of length. Upon the bar G is supported a contact piece or wiper, as will be more particularly explained hereinafter with reference to Fig. 39, which contact piece or wiper always bears upon the wire I. At the distant station, Fig. 37, there may be arranged a circular table, J, having around its periphery a wire, K, similar in all respects to the wire I. Upon the table J is pivoted a bar, L, which bar L carries a wiper or contact point which constantly presses upon the wire K. The contact point on the bar G and the contact point on the bar L are connected by a wire, N, which also includes the battery D. The ends of the wires K and I are connected by wires O and P, and said wires O and P are respectively connected to wires Q and R, which lead to the terminals of a galvanometer, S. It will be obvious, by a simple inspection of the drawing, Fig. 37, that the wires I and K at the separated stations and the pivoted bars G and L, together with the battery and the galvanometer S, are connected in Wheatstone bridge circuit, and that a movement of either the bar L or the bar G, displacing the contact pieces over the wires K or I, will vary the resistance of the bridge arms so that the bridge may be brought into or out of equilibrium by the movement of these bars upon their pivots; and further, it will be obvious that the fact when equilibrium is produced in the bridge will be made manifest by the movement of the pointer of the galvanometer S. The construction is to be such, therefore, and the instruments at the separated stations are to be placed with reference to one another, so that when the bar L makes the same azimuth angle with reference to one end of its wire K as does the bar G, then the

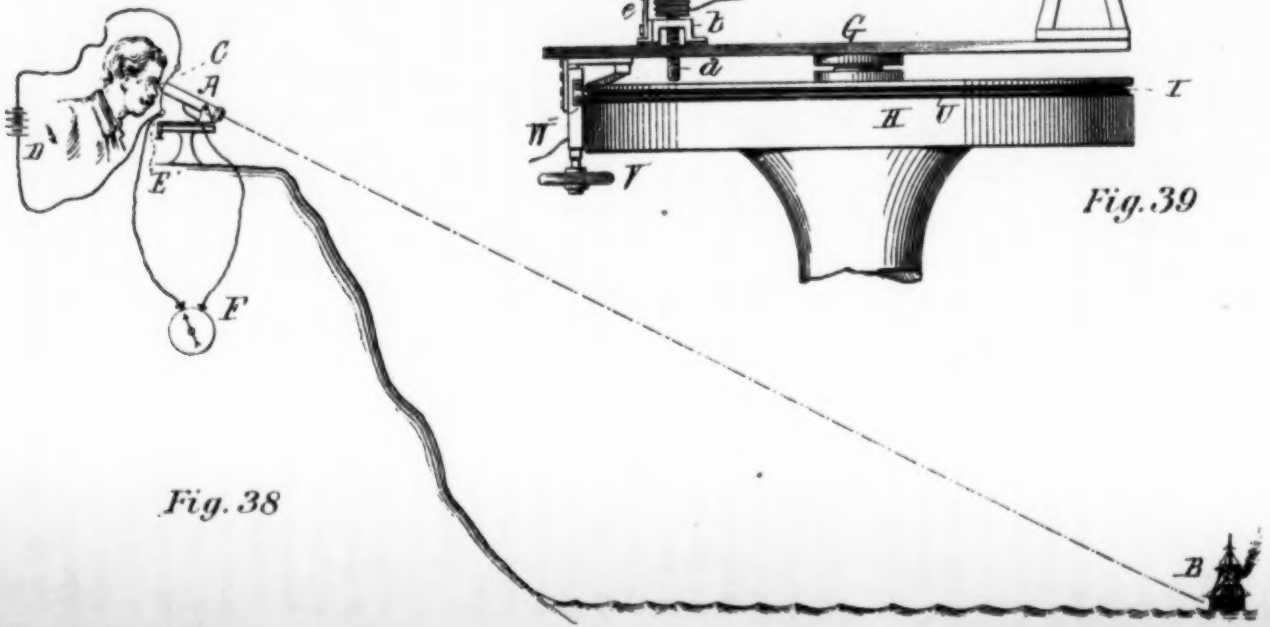


Fig. 38

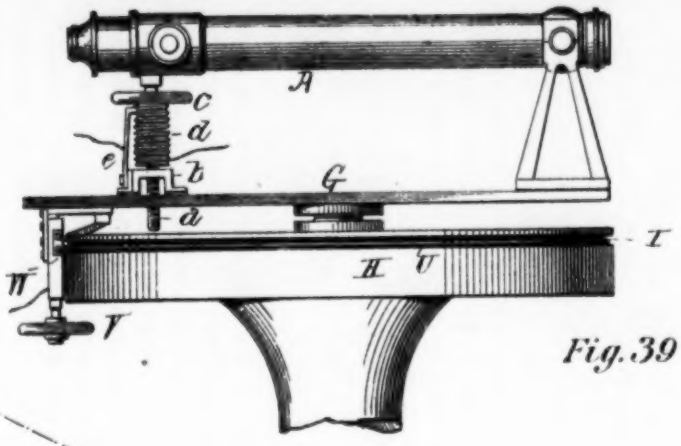


Fig. 39

bridge will balance and the galvanometer S will show zero; so that if the telescope A, and consequently the bar G, parallel thereto, be directed upon the object, the galvanometer S will indicate zero when the bar L is placed similarly to the bar G. If, then, on the table J there be disposed a chart of the area to be protected on a reduced scale, such, for example, as is shown in Fig. 37, the direction of the object from the point of observation will be indicated by the position of the bar L. For convenience in this respect the bar L is made with an opening containing a longitudinal wire, T; the position of the object on the chart being of course along this wire; also on the sides of the opening in the bar L may be marked a scale of distances, in yards or meters.

The operation of the whole apparatus is therefore as follows: The telescope A is depressed, and also moved in azimuth, until aligned with the object. Inasmuch as the distance of the object depends, as has already been explained, upon the angle of depression, and as this angle is measured by the galvanometer F in terms of distance, it is plain that if the galvanometer F be located at the station distant from the observer, then from that instrument the distance of the object can at once be read off. Simultaneously the movement of the telescope A in azimuth disturbs the balance of the bridge which includes the galvanometer S. The observer at the distant station then moves the bar L until the galvanometer S, placed near to him, shows zero. When this is done, the position of the object will be somewhere along the line of the wire T; and its exact point along that wire T is immediately found by noting on the scale on the bar L the distance corresponding to that shown by the galvanometer F. The bearing and distance of the object thus being ascertained, it remains simply to communicate this information, by any suitable means, to the guns or battery.

It will be apparent that one of the advantages of this instrument is that it is directed by a single observer, and that the simple operation of aligning it with the target instantly causes, at the distant station (the bar L there being suitably manipulated) indications from which the bearing and distance of the object may at once be recognized.

Referring now to Fig. 39, there is here illustrated, in detail, the mechanical construction of the telescope A and its supports.

The table H may be of any suitable material, and should have embedded in it a ring U of hard rubber or other insulating material, in which ring is the groove in which is placed the wire I. The bar G is conveniently rotated on its pivot by means of the hand wheel V, the support for which wheel carries the contact point or wiper W. The inner end of the telescope A is supported on the vertical screw *a*, which passes through the fixed nut *b* which is carried on, but insulated from, the bar G, the insulation being placed below the nut. The screw *a* is rotated to depress and lower the telescope by means of the hand wheel *c*. Secured upon the screw is a cylinder, *d*, of ebonite, having upon its surface a spiral groove in which is laid the german silver wire corresponding to the body C, Fig 38. *e* is a contact spring which always bears upon the wire C, and this spring is supported upon, but insulated from, the nut *b*. In this device, instead of causing the telescope A to carry the contact and move it over a fixed body, C, as in Fig. 38, the body C, by the rotation of the screw *a*, is made to move under the fixed contact piece *e*; the relation of the parts being thus merely reversed. The circuit connections are the same as is indicated in Fig. 38, that is to say, the battery terminals lead to both ends of the wire C wrapped upon the cylinder *d*, and the terminals of galvanometer F connect respectively with the contact wiper *e* and one end of the wire C. The movement of the telescope A in azimuth is three hundred and fifty degrees.

Horizontal Base Position Finder.

If the ground in the vicinity of the water is not high enough to offer a sufficiently long vertical base line for a depression position finder, it becomes necessary to use a horizontal base. The solution of the problem of so employing a horizontal base has been attempted during many years, but, so far as the writer has been able to ascertain, the only system that has done it successfully is the one here described, in which telescopes located at the opposite ends of a base line carry contacts which sweep over arcs of wire that are connected together in the same way as in the range finder just described. The position finder referred to in the Italian report, of which an extract has just been given, is of this character. Another form is shown diagrammatically in Fig. 40, in which—

A B represents the parapet of a fortification. The distant object is supposed to be located at C, and it is the position of this object which is to be determined upon a suitable chart, D, on which the fortification line A′ B′ appears on a reduced scale.

E is an arc of conducting material.

F is a telescope or alidade arm pivoted at one end at F′, with its free extremity moving over and making contact with the arc E.

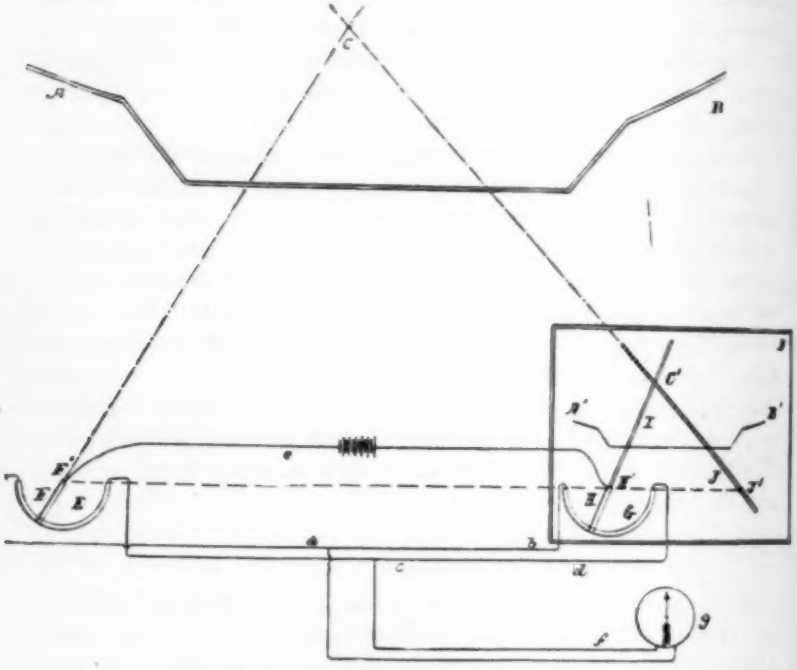


FIG. 40.—POSITION FINDER.

G is an arc similar in all respects to the arc E and located in suitable proximity to the chart D.

H is an arm pivoted at H′ and having its free end sweeping over and making contact with the arc G and carrying a pointer I.

a b c d are members of a Wheatstone bridge connecting the arcs E and G.

e is a loop including the battery, and *f* the loop including the galvanometer *g*.

It will be obvious that when the arm H is set upon its arc G at the same angle to the line H′ F′ as the arm F upon the arc E, then the bridge will balance, and the galvanometer will indicate zero, and hence, inasmuch as the telescope F points to the actual object C, the arm H will point to the corresponding position of the object C or C′ on the chart D. Pivoted upon the chart D at J′ is an arm J, which arm may be provided with a telescope or alidade so that it may be directed upon the object C. The arm J is long enough to make intersection with the arm I. If then the arm J is trained directly on the object, inasmuch as the line H′ J′ joining the pivots of the arms I, J on the chart D corresponds to the base line F′ J′, extending between the distant stations, and as the angle C′ H′ J′ equals the angle C F′ J′, it follows that the intersection of the arms I and J at C′ indicates the position of the object C upon the chart D. The chart being drawn to scale, it is easy to recognize at a glance both the direction and the distance of the object C.

The latest form of this position finder is that installed at Fort Hamilton, and represented in Figs. 41, 42 and 43. The larger of the instruments is fitted with a plotting table as well as a telescope.

The resistance wire for each instrument is wrapped in a spiral around an insulating cylinder instead of being laid in the form of an arc, and differs from the new form of range finder principally in the addition of the plotting table. The operation of using it is much the same as the operation of using the earlier form of position finder just described. The observers point their telescopes so that the cross wires rest on the mast or funnel of the enemy's ship above the smoke. The reader at the plotting table, usually an officer, keeps moving the electrical contact of his instrument so as to keep the galvanometer needle always at zero, thus maintaining the corresponding pointer always in parallelism with the telescope at the distant station. The reader and the observers have telephone receivers on their heads and long distance transmitters on the telescopes, so that they are in constant communication. As soon as each observation is made the officer orders "rest," and both observers cease observing for awhile. At the end of twenty seconds the officer orders "mark." The observers again sight their telescopes on the target and keep the cross hairs exactly on the mast until the officer,

at the end of ten seconds, again orders "rest." The officer now notes the intersection of the pointers and marks it on the chart by a spring pencil, connects it to the position just preceding by a short line, and prolongs this line to an equal distance beyond the last point. The end of this line is clearly the position which the ship will probably occupy at the end of the next thirty seconds, and it is this "predicted position" which is signaled to the guns. But the frequency of the observations and the length of time over which the prediction extends, may be made to vary at will.

With a little practice the work of plotting and predicting positions occupies but a few seconds. To facilitate the operation, the apparatus has been given the form shown in Figs. 41, 42 and 43. The pointers are heavy steel bars graduated every 10 yards up to 10,000 yards and supported at their outer ends on light brass rollers. The spring pencil fits in a slider that moves along one of the pointers. When the slider is pushed along its pointer until its edge rests against the other pointer, the middle of the spring pencil is exactly at the point of intersection of two lines drawn from the centers of the pivots of the pointers; so that to mark the position on the chart of the enemy upon whom the telescopes are directed it is merely necessary to push down the spring pencil with the finger. The distance of the position from this instrument can be read at once from the graduated pointer through an opening in the slider, and the direction can be read at once from the graduated disks shown on the right of Fig. 43.

As installed at Fort Hamilton, the base line is 985 yards. In "tracking" moving vessels and in plotting the positions of known objects situated in different parts of the lower bay, some as distant as 9000 yards, no error as great as 1 per cent. was discovered on the official or the preliminary trials.

Fig. 41.—POSITION FINDER.

Care of the Electric Instruments.

The principal enemy of the electric instruments is the same as that of all other instruments used on shipboard, namely, sea air and moisture. For this reason, the galvanometer cases should not be opened, except when necessary, and should be left open as short a time as possible.

In case of any trouble whatever with any of the electric instru-

Fig. 41.—POSITION FINDER.

Fig. 42 —POSITION FINDER.

Fig. 42.—POSITION FINDER.

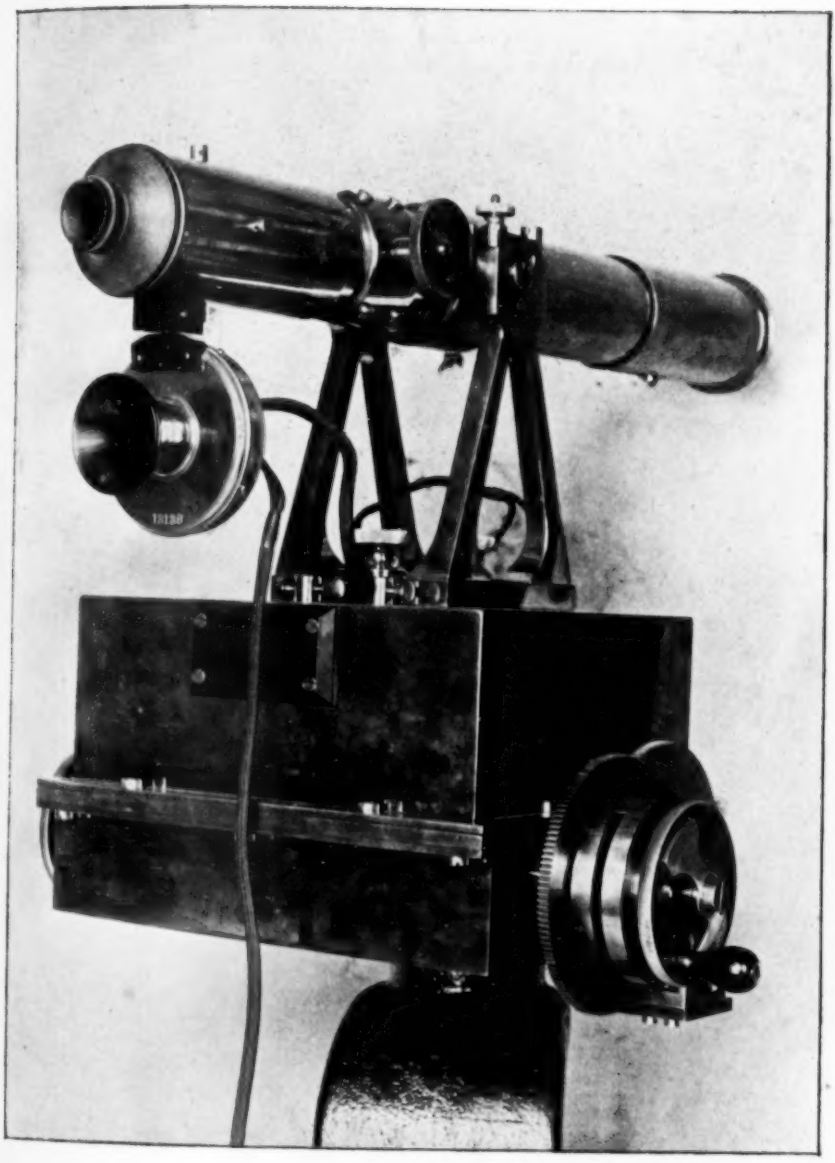


Fig. 43.—POSITION FINDER.

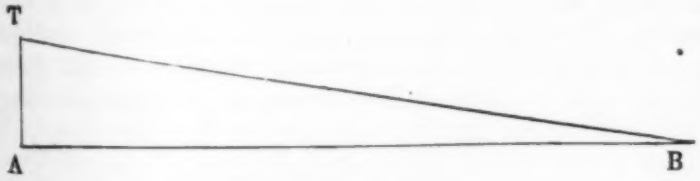
ments, the cause will be, in nine cases in ten, due to a broken wire or connection, or else a connection is faulty, that is, neither firmly made nor completely broken. If the connection is completely broken, a galvanometer will not move at all; but if the connection is merely faulty, the resistance of the connection will vary between infinity and some very small quantity, and cause an oscillation of the galvanometer needle. This may occur periodically, as the rolling of the ship from side to side brings the two loose contacts against or away from each other; or it may occur irregularly and be due to unnoticed causes, such as draughts of air, manipulation by the hands of the operators, or other causes tending to make the loose contacts touch and let go. The remedy is to examine all contacts and connections, and make them firm.

The Stadimeter.

The stadimeter was intended originally as an adjunct to the range finder, and designed to be used in concert with it, in such a way as to combine the portability and convenience of a one-observer instrument with the accuracy of a two-observer instrument.

But it has a distinct field of its own in navigation, fleet tactics, torpedo boat work, and wherever it is desired to know the distance of an object whose height, or length, or breadth is known; or where it is desired to know the height, length, or breadth of an object whose distance is known, the micrometer head M being graduated in yards of distance, the index bar B being graduated in feet, representing the height, length or breadth of the object.

As will be seen from the drawing, it is a modification of the sextant. It is, moreover, of the same size as the ordinary sextant used in ships.

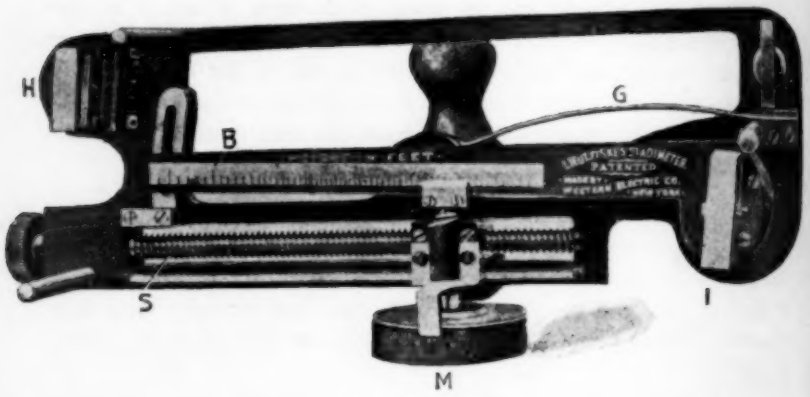


Clearly, from the diagram,

$$AT = BT \sin ABT; \text{ or}$$
$$BT = AT \div \sin ABT.$$

So that in either case the measurement involves the measuring of sine ABT.

To accomplish this with the stadimeter, bring the reflected ray from the top of the object into coincidence with the direct ray from its bottom, by moving the index bar which carries the index glass I on its pivot, in the same manner as in using the sextant. To move this index bar, rotate the micrometer head M. The sine of the angle through which the index glass has been moved is clearly the amount by which the micrometer



STADIMETER.

screw has moved longitudinally, divided by the distance from the pivot of the index bar B to the point on its edge where the force of the micrometer screw is applied. The german silver spring G presses the index bar against the end of the micrometer screw, and prevents lost motion.

Now, by the theory of the sextant, the angle between the reflected ray from the top of the object and the direct ray from the bottom of the object is twice the angle through which the index glass has been moved out of parallelism with the horizon glass H. Therefore, assuming that for such small angles as those here used the sines of angles are proportional to their arcs—

$$AT = BT \times 2 \times \frac{\text{Length of movement of micrometer screw}}{\text{Distance from pivot to point of application of screw on index bar;}}$$

or,

$$BT = AT \div 2 \times \frac{\text{Length of movement of micrometer screw}}{\text{Distance from pivot to point of application of screw on index bar.}}$$

As the length of movement of the micrometer screw longitudinally can be determined by the amount of angular movement of the micrometer head, it is plain that, if we know the pitch of the micrometer screw, the micrometer head can be graduated in units of distance and the index bar in units of height, or *vice versa*.

In the stadimeter this is done, and furthermore the point of application of the micrometer screw on the index bar can be varied at will. This is accomplished by mounting the micrometer screw on a block or nut which rides on the long screw S, so that by turning S the block or nut is moved in either direction.

To use the stadimeter to measure the distance of an object whose height is known, set the micrometer screw opposite that graduation on the index bar which indicates its height in feet, and bring into coincidence the reflected image from the top of the object and the direct ray from its bottom. The distance of the object in yards will then be found opposite the pointer on the micrometer head.

To measure the height of an object whose distance is known, assume the height to be 100 feet, and set the micrometer screw at the 100 mark on the index bar. Proceed as before, and read off corresponding distance (which may be called D) upon the micrometer head. Obviously,

$$\text{True height} : 100 = \text{true distance} : \text{D}.$$

$$\text{True height} = \frac{100 \times \text{true distance}}{\text{D}}$$

The stadimeter may now be set at the true masthead height and used as explained before.

When employed in connection with the range finder in a naval battle, take the distance of the enemy with the range finder very carefully before the action has become hot, bringing her as nearly abeam as convenient, and when distant, say, 2500 or 3000 yards, find out her masthead height simultaneously with the stadimeter, and set the stadimeter at this height and keep it ready for use. If afterwards the range finder becomes disabled, or if it cannot be used for any reason, proceed with the stadimeter.

A moderately skillful observer can get eight observations per minute.

The foretop is a good place in which to use the stadimeter, the observer being connected by speaking tube, telephone, or range indicator with the person who telegraphs the ranges to the guns.

In fleet actions endeavor, if possible, to get exactly the mast-head heights of all the enemy's ships and make a memorandum, to be used when required.

The manner of using the instrument is the same as that of the ordinary sextant, as are also the precautions to be observed regarding the parallelism of the mirrors.

To make the horizon glass parallel to the index glass, when the micrometer reads INFINITY, move very gently the two set screws at the bottom of the horizon glass, slacking one screw and screwing up the other, until the direct and reflected images of a distant object coincide. In using these screws remember that the reflected image seen in the mirror of the horizon glass goes in the direction in which the screws are advanced. If, for instance, the reflected image is below the direct image, screw up the lower screw and slack the upper one. Whereas, if the reflected image is above the upper one, slack the lower screw and screw down on the upper one. Do *not* turn the micrometer head on its screw to accomplish this purpose.

When a very careful observation is desired, as in navigation, it is very desirable to assure the parallelism of the horizon and index glasses after the carriage has been set at the proper height.

Be careful not to force the micrometer head to turn, in case it turns hard, because the reason for its turning hard will be that the micrometer screw is clamped; and if force is used, the head may turn around independently of the micrometer screw. For this reason do not clamp it unnecessarily tight, and do not clamp it at all unless necessary.

The micrometer head is secured to the micrometer screw by the friction of three stout set screws, in such a position that when it reads INFINITY, the edge of the index bar is parallel to the slot along which the micrometer carriage moves on the long screw. If the horizon glass is adjusted to parallelism with the index glass when the micrometer reads INFINITY, and when the micrometer screw is set opposite any height graduation (say 200), the mirrors will remain parallel if the screw is moved opposite any other height graduation (say 60); because the index

bar remains parallel to the movement of the micrometer carriage. But if, from accident, the micrometer head is forced to turn independently of the micrometer screw, then when the micrometer reads infinity, the screw will have placed the index bar at an incorrect distance from the long screw, so that if the horizon glass be made parallel to the index glass when the screw is opposite any height graduation, and if the carriage be then moved opposite to another height graduation, the index bar will also move and the parallelism of the mirrors will be destroyed.

This contingency is not probable, but in case it occurs, the micrometer head can be returned to its correct position on the screw by slacking the set screws and turning the head around till the adjustment marks scratched on the screw and the micrometer head near the set screws come opposite each other.

In case some accident should befall the instrument such that a total readjustment of the micrometer head on its screw becomes necessary, also to adjust during manufacture, proceed as follows:

Place the screw opposite 200, align the index bar approximately by eye, slack up the three set screws, make the micrometer read infinity, and reclamp the set screws. Make the mirrors parallel by moving the horizon glass, until the direct and reflected rays from a distant object coincide, as in adjusting a sextant. Move the micrometer carriage down to 60. Bring into coincidence the direct and reflected rays from a distant object, by turning the micrometer head.

If the infinity mark is now to the *right* of the reference mark on the pointer, it is because the index bar has moved further away from the long screw, showing that when the micrometer head was at infinity and the screw was at 200, the screw was forcing the index bar too far; so that when the screw got down to 60, and was further away from the pivot of the index bar, it did not force the index bar so far, and hence the micrometer head had to be turned to the right, bringing infinity to the right of the reference mark, in order to bring the index glass back to parallelism with the horizon glass.

If when the carriage is moved down to 60, the infinity mark is to the *left* of the reference mark, when the mirrors are parallel, the same reasoning shows that it is because the then existing position of the micrometer screw does not force the index bar far enough away.

Therefore, in the first case, when the mirrors are parallel, the screw is too far advanced; and in the second case, too little advanced.

If on going to 60 the distance in fractions of an inch that the infinity mark is to the *right* of the reference mark is A, turn the micrometer screw until the mark is about $\frac{1}{3}$ A to the *left* of the reference mark and clamp the micrometer screw. Go back to 200 and make the horizon glass parallel to the index glass. Go down to 60. If now, in order to make the index glass parallel to the horizon glass, the infinity mark must still be moved to the *right* of the reference mark, the infinity mark must be moved farther to the left of the reference mark than it was just placed, and the above operation repeated. But if the infinity mark is found to the *left* of the reference mark, the micrometer head has been moved a little too far to the left of the reference mark and must be moved back a little, and above operation repeated.

If on going to 60 the first time, the infinity mark is found to be to the *left* of the reference mark, a distance equal to A, the infinity mark should be moved about $\frac{1}{3}$ A to the *right* of the reference mark, the screw set 200, mirrors made parallel, and the same operation followed as above outlined, until the mirrors remain parallel when the micrometer carriage is at 200 and at 60.

If, when the screw is opposite graduations below 100, the variations from infinity are not more than $\frac{1}{32}$ inch, the error is negligible for practical purposes.

When the proper position for the micrometer head on its screw has been found, clamp the micrometer screw, slack the three set screws on the micrometer head, turn the micrometer independently of its screw until infinity mark is opposite the reference mark, tighten the set screws carefully and then unclamp the micrometer screw.

In case the known height of an object is more than 200, set the screw at 200, and measure the distance correspondingly, which may be called C. Now D, the true distance, is found as follows:

$$D : C = \text{True height} : 200$$

$$D = C \times \frac{\text{True height}}{200}$$

The stadimeter has been issued to nearly all our ships in commission; the New York, being a flagship, has two. The Texas has one for ordinary ship work, and another for use in connection with the range finder, the idea being that constant use of a stadimeter, often in vain, while not impairing its value seriously for use in fleet tactics, will injure the mirrors materially for fine gunnery work between 2500 and 3000 yards.

Note.—Some later instruments are made of an alloy of aluminium and nickel, which is very hard and durable. The weight of a stadimeter made of this alloy is less than two lbs.

Direction of Future Progress.

It would require an inspired prophet to foretell this exactly, but it would require only a man of observation to predict certain phases of it within a small probability of error.

At the present time in various branches of engineering we see the use of electrical appliances gaining so rapidly on hydraulic and pneumatic appliances and on auxiliary steam apparatus, that he must shut his eyes and close his ears very tightly who cannot see and hear the approaching triumph of electricity. Can we then not feel it as an absolute certainty that electric power will soon be used in all our war-ships—and merchant-ships also—for auxiliary engines? There is a predilection in the minds of a few officers in favor of hydraulic apparatus; and many officers like steam. Doubtless there may be some who prefer pneumatic apparatus, but they are few in number and hard to find. The only important difference of opinion, therefore, seems to be between steam and electricity; because steam has the undeniable advantage of saving weight and space and money; but how there can be any question between the relative advantages of electricity and hydraulics it is difficult to imagine. Whatever faults electric power on shipboard has (such as the necessity for a generating plant, the increase of parts, etc.), hydraulics has in at least an equal degree. And it may be iterated and reiterated that every advantage which hydraulics possesses, electricity possesses in an equal degree; and for every disadvantage which electric power possesses, hydraulics possesses another at least equally great. Yet electricity possesses many advantages which hydraulics does not possess, and hydraulics has many disad-

vantages which electricity has not. The whole trend of engineering professions is away from hydraulics and towards electricity. This is true even in ship work, for many people now understand what it means to keep valves and joints from leaking under high pressure, and recall the fact that in the Maine and the Benbow the water simply froze everything stiff and tight, and put the ships absolutely *hors de combat*.

The electrical arts are certainly younger than the hydraulic arts, and yet it is time to cease to regard electricity as a species of illusion or humbug, and to cease to look on an electrician as a species of fakir or magician. As a matter of fact, in all the colleges and electric companies of the country we find men of the highest order of intellect and education engaged in the study of electricity from both a scientific and an engineering standpoint, and the amount of money invested in it is many times greater than that invested in all our ships put together.

So, in deciding between hydraulics and electricity for auxiliaries in ships let us not be blind to the fact that if we decide in favor of hydraulics, we shall take a step backward as judged from engineering progress broadly considered, and place ourselves in the position of the only sensible juryman out of twelve.

Let us hope that we soon shall see a civilized modern ship, in which there shall be a fine large dynamo room, like those under the great New York hotels, where power will be generated for lighting the ship, making the signals, hoisting the ammunition, turning the turrets, operating the telephones, hoisting the boats, ringing the bells, weighing the anchor, sounding the alarms, running the launches, firing the guns, steering the ship, etc. And why should we not have a neat electric galley, such as are frequent in New York, where the meals of all can be prepared in cleanliness and quiet, with only a fraction of the fuss and confusion now attending the getting of the food and the coal and the heating of the water? And why should not both officers and men, when they go on night-watch, frequently in the wet and rain, be given a light repast, cooked on an electric stove, the size of a quart pot? Would the lookouts, or the quartermasters, or the officers, do their duty any less vigilantly if each had half a pint of hot coffee and a piece of nicely browned toast in his stomach? But whatever will be the exact paths that electrical progress will pursue, it is unquestionable that it will

strengthen the hands of the commander and give him better control of his forces both material and personal. This does not mean that a commander—either of a fleet or ship—will be expected to attend to all matters from the conning-tower, because that would overwhelm and overpower him with details which had better be left to subordinates; but it means that he shall be instantly informed of everything that happens, and that he shall be able instantly to give such instructions as he shall think best; it means, in other words, that he shall be able to direct affairs instead of being helplessly directed by them. The real end and aim of discipline is not to put men in the brig or to make them touch their caps, but to give a commander control of the forces under his command, some of which are at a distance. And above and beyond all questions of comfort, and of routine, and of detail, and of beauty, and of the nature of auxiliary engines, and of etiquette, is the question of the control of the ships, and of the various factors, offensive, defensive and directional, which give the ships their fighting value both singly and when combined in squadron. This means that signaling in its broadest sense—signaling both among the parts of a ship and among the ships of a fleet—must be improved, and then improved again and again, with never a rest in the onward march.

Signaling at Sea.

The electrician and the inventor recoil in despair before the difficulties which this problem presents. Guns, armor, hulls and engines change from year to year, but when we wish to signal by day we do the same things that Nelson did at a time when electricity and steam were almost unknown outside the "Proceedings" of scientific societies. Yet there must be a way to signal across the water; the question is "Where is the way?" If we can talk with ease from New York to Chicago, over a distance of 1000 miles; if we can telegraph over the same line 200 words a minute and receive the message printed on a page; if we can photograph the interior of the body of a living animal; if we can telegraph under all the oceans, and send news to and from all quarters of the world—why—why—can we not signal half a mile over the water from ship to ship?

The solution of the problem lies probably in the direction of

electric induction, the transmitters and receivers being so constructed, and so adjusted relatively to each other in resistance, inductance and capacity, that they will be in sympathy, or resonance, with each other, in which condition the receivers will be at their maximum sensitiveness to vibrations propagated from the transmitter.

Many experimenters have attacked this problem, but each, in turn, has been put to rout, "horse, foot and dragoons." Among others, the writer in 1887 essayed his feeble powers, both at the New York Navy Yard and the Stevens Institute. In one experiment he used the U. S. S. Atlanta as the transmitter and the U. S. tug Nina as the receiver, wrapping them horizontally with many turns of wire. The Atlanta's wire was coarse and traversed by the dynamo current; while the Nina's wire was fine and in circuit with two telephones. The Atlanta then formed the largest electro-magnet ever constructed, and she still holds the record; but the experiment, like all the others, was a failure in a practical sense, though signals were transmitted over, say, a hundred feet. On other occasions, the writer, amplifying some experiments of Prof. A. Graham Bell, signaled by means of electric currents propagated through the water. Fairly good signals were sent a hundred yards, but they could not be induced to go any farther. It is to be said, however, that all these experiments in signaling were conducted by the various experimenters in a desultory fashion, and before the laws of electrical sympathy or resonance were well understood. And it is the belief of the writer that, if some competent person were given proper facilities by the Government, or by private parties, he could develop a system of signaling which would be equally good by day or by night, in clear weather or in fogs. Until then we shall have to be as happy as we can with the Ardois system and electric wig-wags; unless some good magician, with a wave of his wand, will bring into being some simple and beautiful discovery or invention, the like to which we do not dream of now.

Central Stations.

The problem of insuring rapid and sure communication among the various compartments of a war-ship has brought about the

same solution as a similar problem has brought about in modern cities—a "central station"; and the more the subject is considered, the more plain it becomes that a central station is the only thinkable solution in a city, a large building, or a ship. And not only this, but in a war-ship the solution is the more complete, because, added to all other conditions of the problem, is the important one that the means of communication and the operators must be as much protected as possible. It is an admitted fact that the problem of where to put the conning-tower and how to arrange it has not yet been solved, but the central station below the water-line comes pretty near solving it, because much, if not all, of the complicated apparatus heretofore put in the conning-tower can now go in the central station, and the captain needs only a telephone or large speaking-tube connecting him with his aide in the central station. The conning-tower being thus relieved of most of its apparatus, can be made smaller, and for a given weight, covered with thicker armor, so that it will be extremely hard to hit and almost impossible to destroy.

It has been proved in service that speaking-tube communication, or even telephone communication, is very inefficient between the conning-tower and those parts of the ship, such as the battery, turrets, engines, etc., in which there is much noise; and that it is utterly useless for communicating simultaneously with several persons under the conditions of action or even general quarters. But telephonic communication can be made perfectly satisfactory between two people, one in the conning-tower and the other in the central station; because a central station can be made quiet, and because the two people, say the captain and his aide, can keep their telephone receivers on their heads all the time and become accustomed to each other's voices and modes of intonation. Then from the central station reach out the various visual signals for silently telegraphing ranges, battle orders, directions to the helm, engines, etc.; and there is received news from all parts of the ship for transmission to the captain. The central station should be as near the conning-tower as possible, for obvious reasons; but even if in some ships it should have to be at some distance, yet the telephone will put matters in the same condition as if the captain and his aide were absolutely in the conning-tower together and holding verbal communica-

tion. Aside from the value of protection for all the interior signaling apparatus, both for sending and receiving, the advantage of having all the operators in a quiet place, where they will be as free as possible from exciting and disturbing causes, is clearly of paramount importance

It is to be hoped that the tremendous advantages to be derived from a central station properly situated and equipped will be more and more fully recognized, and that in the original designs of our new ships the central stations will be really properly situated and equipped. It would seem that the principle governing the arrangement of electric apparatus in ships should hereafter be the same as in large establishments on shore, viz., that all apparatus which is delicate, or which requires great skill in its operation, should be confined to the central station, and that the apparatus placed elsewhere should be of the simplest character, as regards both its construction and its manipulation.

If this plan were adopted, we could get rid of the armored tube with its multiplicity of chains and wires, a blow on which from a heavy shell would paralyze all means of communication and leave the captain helpless. We might even get rid of the conning tower itself; because all that would be needed would be a strong steel post, or bar, behind which the captain could stand, like a sharpshooter behind a tree; with perhaps a quartermaster near him, to direct the helmsman in the central station.

It is now proposed that the executive officer shall be stationed in the central station in action, in order that, if called upon to take the captain's place, he shall be *au courant* of what is going on. If this be done, why should not the executive officer be the gunnery officer of the ship, and charged especially with the matters relating to her fighting efficiency, her guns, turrets, electric mechanism, etc.? Then he would, if called on to assume command of the fighting machine, do so with an intimate knowledge of all her fighting factors, instead of with an intimate knowledge of liberty lists. But, as Rudyard Kipling would say, "That is another story."

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NAVAL WAR COLLEGE.

OPENING ADDRESS, SESSION OF 1896.

Delivered June 2, 1896,

By HON. WILLIAM MCADOO, *Assistant Secretary of the Navy.*

Mr. President and Gentlemen:

I thank you for the unusual, and I fear, unmerited honor of again being asked to address you at the opening of another session of the War College. It is unnecessary for me to say to you how successful this institution has been. Those who are concerned with the administration of the Navy have learned to regard it as one of the great arms of the establishment for national defense. The military art, like others, has been progressive; and preparation, method, and order are the prime factors for success. Our Civil War revolutionized naval architecture, and the Franco-Prussian War demonstrated that careful organization, deep study of possible problems, and a thorough knowledge of a nation's resources, as well as the strength and weakness of one's opponents, can overcome the bravest people under otherwise able and gallant leaders. In short, the largest side of modern war is the business one. It is quite possible that no amount of preparation and organization could save a nation of cowards, but while races may differ in bravery, no nation is wholly wanting in the heroic. This school, therefore, is doing a work for this country of an importance so great that it could not well be exaggerated. While it is possible that every solution attained here may not be a perfect one and would have to give way to changes in the face of actual facts at the time of conflict, still there can be no doubt that the plan of national

defense from the naval standpoint, so thoroughly elaborated here, is of the greatest value to the country, and would receive primary consideration in case of war. The College does not pretend to stand for the whole ability of the United States Navy. No college can give a man genius, but a course in college will help most men of even great natural ability. I am saying this by way of prelude to the subject which I have chosen for to-day's address. Dropping into a habit which I notice is assumed by certain popular preachers, of prefacing their sermons with a few comments on the events of the day, I briefly recapitulate the line of thought suggested in the former addresses, namely, that force is yet, and will continue to be for long ages, a prime factor in civilization; that the diplomacy of a nation, however able, carries with it no weight unless backed by power, especially on the sea; that war in a republic is apt to be more sudden and precipitous than under the most autocratic of monarchies; and lastly, that we, as a nation, have reached the point in our career where, whether we will it or not, we are obliged from inexorable circumstances to assume great international responsibility and obligations, more especially on this hemisphere.

I am quite aware that these views do not harmonize with those of some of the learned schoolmen of our day. To those who hold these views this is not a matter of serious import; to be learned is not always to be wise; to be prejudiced and conceited is to often fail to be patriotic; to dream one's premises instead of knowing them is not to reach sound conclusions. It is instructive and reassuring to glance along the lines of the imperial progress of the Republic and note the illustrious but discredited Jeremiahs who have wailed their protests against such advancement. They rent the heavens with protests against the annexation of Louisiana, and prophesied that our acquisition of that territory, with its mixed peoples, would be the destruction of the American Constitution and Anglo-Saxon civilization. They protested before high heaven in the Congress of the United States against the War of 1812, and invoked the illustrious shades of English literature, in whose genius we have a common pride, to halt us in the assertion of our national rights as against a position of colorless colonial dependency. They poured hot vials of satire and unsparing abuse on the loyal public men of the day who had the nerve and manhood to engage in a conflict

which, for the first time, gave to the United States a place among the great nations of the earth, and won for its people and its flag enduring respect on land and sea. They anathematized the heroic American who carried our flag into the capital of Mexico and added to the national territory; and in the period which preceded our great Civil War, were their unfruitful prophecies, oral and written, collected into one vast heap, it would reach so high as to be crowned with eternal snow, as they are now with the mould of disuse and disrespect. In the dusty subcellars of public libraries lie mouldering heaps of this literature of false premises and absurd conclusions. These false prophets are good men too overburdened with their own virtues and cruelly overladen with excessive wisdom; otherwise men of learning and high social position.

From dizzy, platitudinous heights, with a delightful self-complacency that excites smiles instead of frowns, they have protested against every forward movement with a dull dogmatism which, if it were as weighty in fact as in assumption, would arrest the spheres and crush the world. Heedless mankind, with a void in its stomach, an impulse in its heart and an idea in its head, goes resistlessly on in its own blind way, and these sons of omniscience go theirs.

He must be wholly ignorant of the existing facts around us, and unobservant of recent occurrences and their significance, who does not realize how much naval strength makes for our peace, the security of our rights, our commercial growth, and the assured success of our policies. A proper navy would do more to secure peace for the United States than endless speeches and pacific resolutions. It is not the armed but the unarmed nations that are in danger of war, spoliation and outrage. In the political world, as in the natural, inertia and stagnation mean death; activity and the contest of opposing forces stand for life. This country of ours cannot stand still, nor can it evade the awful responsibilities of destiny and environment. The accidents of time may retard but they cannot prevent the great events of destiny.

The subject which I have chosen for to-day's address is Naval Administration. I think you will all agree with me that however able the personnel of the Navy may be, however excellent the matériel, unless the establishment as a whole is well orga-

nized and properly administered, the Navy cannot be efficient. A bad or lax administration in time of peace makes a navy incapable of carrying out the wisest solutions of any problem in time of war. This subject of naval administration has long been a subject of discussion and dispute, because every one realizes how entirely essential it is to the carrying out of the ends for which the establishment was created and carried on. A weak, foolish, or worse administration of the Navy would discount all the bravery and ability of the military units that go to make up the organization. The best troops will fail in the hands of a commander in whom they have no confidence; the best business will be wrecked if those at the head are incapable of executing its affairs. The machinery of naval administration is complex, and more difficult to handle in many ways than that of other branches of the Government. In the first place, it is a military body, or at least it ought to be. It is not a line of merchant steamers, nor a manufactory, nor a hospital, nor a counting-room, and yet it combines the characteristics of all these. And over this purely military body, under the constitution and laws of the country, there is one supreme civil head, the President of the United States, and under him, as his direct representative, the Secretary of the Navy, also a civilian. At the outstart, therefore, we have apparently presented to us the anomalous situation of a civilian head, possibly untrained in the military art, and almost surely without naval education, placed in direct, entire, and unquestioned control of a military organization, hedged about with questions of the most technical and difficult character from the purely professional point of view. And yet, under our system of government, this is the only possible way in which a military establishment could at all exist. Under popular government, either in England or the United States, the military arms are to be always subordinated under the constitution to the civil authorities. In other words, the people are unwilling to divorce the military branch of the Government from other branches of the governmental machinery, or to allow it at any time to get beyond their control. To this end, it is the policy of all popular governments that the military organizations shall be kept in close subjective touch to both the legislative and executive branches of the Government, and there is no reason why, under wise laws and able administrators, this plan

should not work well. It is no disrespect to the highest professional opinion to note that in the affairs of the world, the trained minds of the judges of our courts and the administrators of great businesses, and indeed even the juries, have every day to pass final judgment upon technical subjects, and often settle disputes as to rival professional claims. As I said, however, its wisdom or unwisdom need not be discussed, because it is an established fact which can not and will not be changed. At first glance it would seem to create a very delicate relationship between the head of the Navy Department, as the civilian and supreme administrator, and the professionally educated officers who are subject to his command, and through him carry out the orders and policy of the government of the day. It begets for the naval officer in a country like ours, where public opinion is so critical of all in official stations, and so free in its expressions, a position requiring sound judgment, good tact, and a high degree of patriotism.

He is of course bound, as is proper, to give implicit obedience and respect to the civil authority, and on the other hand, from the professional standpoint, he is, in the nature of things, more or less divorced from the ordinary pursuits and politics of his fellow-citizens. He must avoid extremes. He cannot become so narrowly professional as to get entirely out of touch with the country and its institutions, nor remain ignorant of the facts, events and occurrences of the great life which struggles and surges around him. And on the other hand, as a professional military man, bound on sacred honor to obey the proper civil authorities under the constitution, he cannot, without impairing his usefulness and losing his professional character, become an active partisan in the politics of the day, nor an eager participant in commercial and business enterprises. There is some analogy between the soldier of the cross and the soldier of the sword in their relations to the state and general society. They must mingle in the affairs of their fellow-men and yet, in a certain sense, they must stand apart. A high sense of honor and great disinterestedness should be the badges of their calling. Between these possible difficulties there must be a sound middle ground for an American naval officer. He should of course not be a politician—certainly not in the ordinary sense—but on the other hand, if he does not from active sympathy take a deep and abid-

ing interest in the affairs of his country, its prosperity at home and its dignity abroad; if he is lacking in the American spirit and out of sympathy with American institutions, and not thoroughly cognizant of the relationship which he bears to the Government as a member of one branch of the same; then, however marked his professional zeal, and however great his ability, he is in a false position; however otherwise honest he may be, he cannot bring to his work in a crisis that hearty enthusiasm which is only to be gotten by the stimulation of unselfish patriotism. I glory to say that, so far as I am aware, these possible dangers have no personal application to the officers of the United States Navy, and I only refer to this subject because I feel convinced that frequently the Navy, as a branch of the Government, an organization and an institution, presents itself to many circles and communities in our country simply and solely by the character and bearing of the individual naval officer with whom they are acquainted. Every naval officer in his own immediate circle, be it small or great, represents to a certain extent the whole Navy, and his manners and opinions make for or against the establishment. If it should once be suspected that he was out of sympathy and touch with the citizenship of which he is a member, or that he had gross misconceptions as to his relations to the Government and the people, he would, so far as his personal limitations admitted, be a source of weakness instead of strength to the Navy.

I was amused recently by a very excellent officer who said to me that when he made his occasional visits to the small town of the interior of the country where his people lived, that he was immediately greeted by the wiseacres of the village, who exclaimed, on seeing him, "Well, Bob, we see the United States Navy is home again." If you will ascertain the standing of that officer in the town you will come pretty close to getting its opinion on the naval question. I want the Navy to be popular because it deserves to be, and in a government like ours all institutions depend upon the good-will and support of the people, who, being in the main highly intelligent, demand reasons for the existence of everything around them. The naval officer will be at his best who is too professional to be a politician and not enough professional to lose interest in all the affairs of his country, never ceasing to be a student of her history, both civil and mili-

tary, and indeed to exercise his rights as a citizen when he so elects and opportunity offers. No one can realize better than the civilian head of the Navy, that while the Navy is a great and important branch of the Government, it is not all the Government, and the different parts of the governmental machinery are correlated and they all are subject to the policies, conditions and even passions of the times. It is, therefore, not so much what he would wish as what he can do; nor what would be the ideal conditions, but the best that can be gotten out of existing circumstances; nor so much how to manage an isolated and independent thing by itself, as to keep it in harmony with all the surrounding conditions and in quick touch with the most enlightened popular public opinion. It is a task requiring great judgment and marked ability, and it is not amiss for me to say, as this administration nears its close, that the present Secretary has shown himself equal to meeting it. I said we were not dealing with ideal conditions. I am foolish enough to think that if I were asked to recast the present system of administration, I would make many improvements in it; and I am quite sure, if it were left entirely to me, I would not hesitate about increasing the Navy, both matériel and personnel, to a proper degree of efficiency, but the advancement of a great principle like this is slow, painful and difficult. Like all human institutions of great worth, it has to rise steadily in the face of opposition and obstruction, both open and covert. It is strikingly strange, that those things which have most benefited mankind, even the Christian religion itself, have traced their pathway of progress through great peril and violent opposition.

To best understand the present naval administration it would be well to compare it with that of Great Britain, which can be readily done by reference to an excellent little book just issued, entitled "Naval Administration," by Sir Vesey Hamilton, late First Sea Lord of the Admiralty. The first thing to a successful administration by an incoming Secretary of the Navy is the selection of his professional advisers, in so far as opportunity is offered to him to do so. He must, in the nature of things, rely largely on them for the solution of the many professional and difficult questions which present themselves. To make a successful administration he should have at immediate call the very best professional talent in the Navy and occupying towards him the

most confidential and responsible positions. His term of office is fixed by law for four years. It has what might be termed its primary, intermediate and final stages. If he has not been fortunate enough to have gotten into the naval atmosphere through legislative or other connections with the establishment, he must, of necessity, however great his talents, begin an entire education, rapid as to time, and yet more or less comprehensive, before he can understand the duties of his office and the best interests of the service. He should be deeply concerned as to both the ability and wisdom of his professional associates. Under our system he has under him eight bureaus with their accredited chiefs, who in some degree might be said to constitute his cabinet. They do not, however, come into office with him, nor do they go out with him, but, as you know, come and go at irregular periods. Under the English system the member of the Cabinet who is at the head of the naval administration, and who, although theoretically but one of a commission for executing the affairs of the Navy, has practically the same powers as has the Secretary here (and in fact larger, as there is no reference to a superior authority such as the President), has associated with him four admirals who share his counsels and responsibilities and among whom are divided the superintendence of the detail's administration. It has not been so many years since the personnel of the Board was completely changed with the change of government, but this is no longer so. The incoming minister may either accept the existing Board or select a new one as he may elect, or he may call in new members without changing the whole Board. The Secretary of the Navy there has the same authority as with us, and although it has come to be held that he alone is responsible to Parliament and the country, and although he can veto the conclusions of the Board or those of any member of it, it is stated on high authority that he has never been known to do so in any important question, and indeed it has been said by English students of their system that the Cabinet member has performed his greatest and most essential duty by the selection of men of the best character and best fitted for membership on the Board. Indeed a Secretary of the Navy would have to be omnipresent as well as omniscient to pass successfully, of his own knowledge, on all the affairs of a vast establishment like this, scattered throughout our own country and all over the world.

The facts must filter to him through many sources, and his final information and advice must come from those officers who are the responsible heads of the different bureaus. Not alone is it necessary for the Secretary of the Navy to make wise selections for the distinct sea commands, but under our system he is called upon to make a great many selections for the manifold and various duties which are now given to naval officers.

Answering to a public demand, it has become the custom to place under naval officers a vast amount of work and the exercise of responsibilities entirely apart from those of a purely military character. It is the common experience of mankind, in both state and church, that however similar the professional training, the talents of men in any profession will differ; and indeed it is the trend of all professions in modern times to beget specialties in different lines. It therefore frequently happens in the Navy, as in other walks of life, that certain officers show great aptitude and develop natural talents for certain kinds of work outside of the limits of the strictly naval profession, and these officers do probably in these selected lines perform greater service for the country than in the strictly professional one. Under our system, however, the rule of rotation between sea and shore is more or less general. It is not necessary at this time to discuss its wisdom. Under the plan of selection as recently proposed in Congress, changes in this respect were contemplated. While in answer to public demand the duties of naval officers have been extended in many directions to the assumption of advisory, ministerial, and administrative functions, it might be well to consider if the present system of frequent and arbitrary changes in those employed in such service is beneficial or otherwise. It is quite possible that I am heretical regarding certain traditions of the service. As I have said, naval officers, like all other men, differ in their character and personality. There are some things which one officer can do very well, and there are other things which he can do but poorly. I venture to suggest that Lord Nelson could not make a watch, and I am really vain enough to think that I know as much about farming as did Farragut. Perry and Macdonough might have been poor lawyers, and some great sea captains would make poor bank presidents. In selecting officers, therefore, for important duties, it seems to me—as I say it is possible I am heretical in the matter—that the

primary consideration in the matter is their ability to fill their particular place, and all this with the highest regard to the essential qualifications of rank in a military establishment. The Secretary of the Navy is bound to pay the greatest heed to the recommendations and findings that come from officers selected for these manifold duties, either individually or as boards. In so far as he has personal knowledge of the men to be selected, can any greater task be imposed upon him than to make wise selections with full regard to the character of the special duty and the ability and fitness of the officer selected? In other walks of life men are not selected so much for availability as for fitness. Just because a lawyer happens to be doing nothing would not generally lead to his being selected for Chief Justice of the United States. The Secretary's duties under our system are much more onerous than under that prevalent in England. There, too, his responsibility is as great as here. But this responsibility is shared by the Board, or what might be called high court of appeals, which, in addition to its responsibilities, is also given a much larger field of discretion in the exercise of its powers than with us. The British system is characterized by two things: flexibility of operation and rapidity of action. Its source of power rests in the royal patent, and, singular to say, that while the wording of the patent has not been changed in hundreds of years, the system itself under it has been recast and remodeled often. By its silence Parliament has consented to the exercise of powers not strictly granted by the charter, and the whole system, which is very elastic, very adaptable, and under which the machinery is given full play and is totally lacking in rigidity, has grown up by accretions and experimental changes, and is based on experience. Our own system, by comparison, is more rigid and detailed, more given to the letter than the spirit. Of course, in some respects the British system would be entirely unsuited to our country and institutions. Our organization, with some changes and modifications, in the hands of an able administrator, would be better adapted for us than even the British system is for them.

Whether a certain naval organization is best or not can only be determined by confronting it with a crisis or an event in which the full play of the whole machinery has to be brought instantly into requisition. The useless, weak, and ill-adjusted parts will

then be sure to show themselves. The existing British system, within recent years, received a severe shock. On the very day that the Russian note presaging war reached Great Britain it was found instantly that changes in the naval administration to confront so grave a crisis would have to be made, and on the elastic terms of the patent such changes were immediately put in force. Then again, when the war-ship *Captain* foundered, the question as to who was responsible excited the whole of Great Britain, and the existing system was subjected to Parliamentary and other inquiries as to who was blameworthy for the improper building of that ship; in which case, by the way, you will remember, the court-martial decided that she was improperly built "in deference to public opinion expressed in Parliament," and against professional advice; a finding which seems to imply that a man might be a good orator in Congress and a very poor ship constructor. To locate responsibility, the British system aims at centralizing authority in the fewest number of individuals, and giving those the greatest scope of authority over those under them, and all parts of the machine at all times to be governed by the final decisions of the Board.

Our present naval administration, under existing laws, is well and wisely administered, so far as the Secretary of the Navy can control it, and yet I fully believe that in the event of war it would, of necessity, have to be changed and modified in many respects, both with regard to the efficiency of the personnel and matériel. In England the control of the personnel is subdivided under two or three Lords, each acting in his own sphere, but all are members of the Board of Admiralty. Under the existing conditions with us a tremendous amount of labor is thrown on the Secretary of the Navy by this side of the establishment, and while no one would advocate restricting his paramount authority, or lessening his responsibility, it is, I think, worthy of consideration, whether his professional advisers on this subject should not be increased and be subject to his own personal selection on coming into office. Under the British system the whole of the matériel is subject to the Controller of the Navy, who virtually regulates the actions of what would be equivalent to four of our bureaus, keeping them in touch and harmony in the work of constructing and equipping a completed ship. It is encouraging for those of us who believe that the present system can be made

more perfect, to note from Sir Vesey Hamilton's book that the reforms of grave and almost intolerable abuses, maladministration, and weaknesses in the British Navy were a work very slow in its accomplishment and gradual in its development, covering, indeed, a period of hundreds of years. The British system had at the start one great physical weakness in the scattered conditions of the offices relating to the Navy Department. These were scattered all over London, so that a man might travel a great deal if he had business with all the various officials of the Admiralty. With us, happily, the offices, with one or two exceptions, are in one building, and even these should have their headquarters there, so as to be in direct personal contact with the head of the Navy. I am not here to propose any radical remodeling of the existing system; for while, as I have said, I believe that it could be modified and improved so as to get the best results for the Navy and the country, I think that all work of change and reform should be gradual and normal, step by step, as experience indicated, innovations to be retained and made permanent only after fair trial and by the results attained. There is one thing certain: we have now reached that stage in naval development in this country when a proper and wise administration of the Navy and remedial legislation regarding the personnel are imperatively demanded. In the nice adjustments of the plans of power between the legislative and executive branches of the Government under our system it is not to be expected that the same wide range of discretion, the same exercise of broad powers, without recourse to legislative action, will be given to our executive officers as is done in Great Britain; and yet, under the laws as they are, very wide and proper discretionary power is lodged in the Secretary of the Navy; indeed, so much so, that when the former Secretary of the Navy, Mr. Whitney, presented a scheme of legislation for the consolidation of bureaus and a more centralized system of administration, it was argued by many in Congress that those powers already resided in the Secretary, and that no additional law was necessary. I think, however, that it would be wise if the Secretary of the Navy, on coming into office, could be given by law authority to call into his counsels, if he so desired, additional professional advisers, and so arrange the existing system that it could act with less friction, greater adaptability to circumstances, and produce quicker re-

sults, with possible economy to the Government. I think I am not misstating the case when I say that the great number of temporary boards called rapidly into being to pass upon manifold questions regarding the matériel and other questions shows that the Secretariate finds itself frequently in need of advisers near at hand to pass upon numerous professional questions demanding an immediate settlement. It is a question which I will not undertake to settle, or to pass upon, whether some one officer, such as a chief of matériel, or a board representing all branches of the service, such as an advisory board, should not at all times be close to the Secretary. It is not disparagement of the present excellent Board on Construction to point out what appears to be a weakness, and one which a lawyer would readily understand. It has been found, for instance, in most of our States that the court of last resort ought not to be composed of judges who go on circuit and try cases; that the community of individual interests among such judges, and the atmosphere of active litigation unsuit them for their higher functions or dispassionate consideration on appeal of abstract propositions. In Great Britain the Board of Admiralty, which is the supreme deliberative body, controlling and regulating the whole establishment, meets in session nearly every day. Under such a system as this, would it, or would it not, lessen the great number of advisory boards of investigation, courts of inquiry, courts-martial, and the distracting frictions and controversies of rival bureaus and their satellite appendages? This seems to me a question worthy of consideration. While most Secretaries of the Navy, very properly, do not court any additional responsibility by grant of Congress, and are more than willing that the legislative body shall take the full share of all responsibilities, still it is an open question whether it would not be wise to enlarge the Secretary's rights and powers with reference to the administrative methods of the Department. Rotation in office in Great Britain, which relates only to those highly placed, does not interfere with continuity of policy, and yet is sufficient to beget activity. I think you will all agree with me, that the present system of rotation among chiefs in the Navy Department has advantages over that prevailing in the War Department.

I have spoken now of the relations of the naval officer to the civilian head, and have suggested the wisdom of modification

of our existing system of naval administration. Before closing I wish to speak briefly of what, in my judgment, is a great national want. The defense of the United States against all foreign foes should be a unit, at least as to plan and preparation. There ought to be, and I am quite sure my friends of the Army will agree with me, a closer connection on this subject between the Army and Navy. The ship and fort are both essentials in national defense, and what are to be the functions of one and the other, as to what is to be the probable strength of the enemy, and the plans of defense against him, these two branches of the service should be in complete accord. I think every one will agree with me when I say that all the naval and military information should be, generally speaking, in common. I hope to see the time when there will be a board composed of army and navy officers, and called, say, "Board for the Military Defense of the United States." The present Board on Fortifications of the Army has lay representation, and this, if found advisable, could be added to this enlarged and more comprehensive board. Under such a board advising the President and Secretaries of War and the Navy, there would be a unification of arms and ammunition, perfect unity of purpose as to plans of defense, thorough harmony and co-operation as to the best policy regarding legislation, and a resultant enlightening of public opinion of which the country stands so sorely in need. So far as the Navy is concerned we have made a fair beginning in building up the matériel, but we are as yet far behind the needs of the nation, and I fear that the public are frequently misled by the high and just praises bestowed upon that which we already possess, into thinking that we are stronger than we really are in fact. The ships which we have built are excelled by none in the world; that we have constructed them under the difficulties and conditions that we did, seems almost miraculous. The guns, armor and ammunition have, admittedly, no superiors anywhere, but we have not enough of them. I cannot find language strong enough to condemn the criminal folly which leaves this nation practically unarmed. In the face of portentous happenings and dire possibilities, we are practically without any stores of small arms, and have no spare guns in the Navy, and a very limited supply of projectiles. In the question of small arms there should be in this country, beyond those necessary to arm all existing

military organizations, both the Army, Navy and Militia, a surplus supply of at least one million modern rifles, capable of being instantly put in the hands of the citizen soldiery. These small arms cannot be manufactured in a day, or a month, and when war comes it comes suddenly. Not long ago a distinguished and patriotic Senator, speaking to me, said that in a certain crisis ten million armed men would follow the flag. I might have said to him that we did not have rifles sufficient to arm one-fortieth of them. I am criticising no one either in the Army or Navy, but I think the facts speak for themselves, and I am quite sure if the people of the country were once thoroughly alive to the situation and its possibilities, that they would demand that measures be taken to create a proper supply of arms. No one can possibly object to this, not even my good friends who expect the millennium by an act of Congress or governmental treaties. These stored arms would of themselves be as inoffensive as so many volumes containing the annals of Arcadia.

I am glad to say that the present Congress has made provisions for creating some surplus guns for the Navy. No work could be more timely and necessary. Many of the American powers on this hemisphere, both colonial and independent, are much better off in this respect than we are, some of them having recently laid in large additional stocks of modern rifles, rapid-fire guns, and guns of heavy caliber. The exact number of surplus rifles in the United States at present is totally inadequate to a ludicrous degree, to the number that would be required at the very first outbreak of war. It is a fact, too, not recognized by the public, and not sufficiently recognized by Congress, that there is no open market in which munitions of war can be purchased. A recent inquiry made by the Department developed the fact that in the whole of Europe there was but a ridiculously small number of rifles, rapid-fire guns and those of large caliber which could be purchased. And the same applies to projectiles, powder, and all the munitions of war. As far as I am informed at this moment, there is scarcely one gun of modern caliber which could be purchased in open market. The great nations of the world carry large surplus supplies, and all the arms and munitions of war manufactured within their own borders, either by themselves directly or through contract, are kept for their own use, so that if we should be opposed by a single nation with no

allies, and all other countries were friendly to us, it would be impossible for us, with the limited means at our command, to make such rapid arming as the situation would demand. The capacity to produce, too, is limited in the physical nature of things. The machinery for the manufacture of arms and ammunition has to be especially constructed, is of a very costly and delicate nature, and requires skill and experience to operate. It cannot be improvised. The armories, arsenals, and manufactories, under government control, have physical limitations already existing as to their capacity of production, and these, taxed to their utmost and employing every possible man, and operating every machine, would not be able to meet the reasonable demands of war, from the possibilities of which no nation is ever free, and we certainly no more than others. Great wealth, material and resources, immense population, extensive territory cannot overcome lack of military preparation, organization and method. If it were otherwise the Japan-China war would have had a different ending. Moreover, the whole mechanism for the production of military weapons, including ships and forts, has made rapid and startling advancement. The modern gun is an article of slow and careful manufacture, incapable of being constructed by rapid castings or being turned out in large numbers with great rapidity. The fine old wooden sailing frigate, with her crew formed to repel boarders from the enemy, is quite a different thing from the massive, powerful, complicated and slowly constructed battle-ship of modern times. We do not repel boarders now, but we have to look out for a more deadly enemy in the torpedo and the torpedo-boat. We cannot create battleships as they built gunboats on the Lakes during the war of 1812. These great machines are worlds within themselves, and comprise the whole sum of human knowledge with regard to mechanism, chemistry, and the highest attained scientific knowledge. When the united services of the Army and Navy are brought into thorough and more familiar conjunction, these and kindred subjects will be more readily impressed upon the public intelligence, and will more readily secure Executive and Congressional action.

In conclusion, let me say that, earnestly concerned for the success of the Navy, I do sincerely trust that those in whose hands its administration will be entrusted in the future will continue, as their predecessors of all parties in the past have done, to treat

the Navy as a national institution, far removed from all partisan and personal considerations, and entitled to a broad and catholic treatment on high national grounds. It is a great honor to have been concerned in the administration of an institution so deservedly popular and of such infinite value to the country. The Navy is a military organization, and while the military atmosphere would seem to be foreign to the spirit of republican institutions, yet every one will recognize that a war-ship, for instance, conducted as a little republic, would be about as efficient for the purpose for which it was created as an excursion steamer. While the military arm of the Government is to be strictly subordinated to the civil, yet it should always be remembered that the hereditary features of a military organization are, of necessity, if it is to be efficient, the same under all forms of government, and that undue outside interference with its details will emasculate and destroy its usefulness for the very purpose for which it is maintained. If the military machine is to reach a high standard, and be equal to any crisis, it must continue to be permeated by the proper spirit, discipline, customs, and traditions. Within certain limits it should be ungrudgingly allowed an isolation from undue interference without, so that under the guidance of able and skillful professional men it may reach its best development. The more efficient the Navy becomes, from a purely professional naval point of view, the less a citizen, however conservative, need fear its growth, for its essential and paramount principle is absolute and unquestioned obedience to the constitutional authority, the defense of the integrity of the Republic from without, the vindication of its dignities and rights abroad, the protection of our citizens, the extension of our commerce, the maintenance of our eminent position among the great nations, and, finally, the greatest assurance for permanent international peace, a peace founded on respect and marked by honor.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

SHRINKAGES (APPLYING CLAVARINO'S EQUATIONS).

By LIEUT. J. H. GLENNON, U. S. Navy.

Let R represent the radius of the bore, R' the radius of the surface of contact of a hoop or jacket with the cylindrical inner body (which may be either a simple tube or a compound tube put together in any way whatever, provided always that the modulus of elasticity is and remains constant throughout, and that the elastic strength of the metal is not at any place exceeded at present or at any future stage), and R'' the external radius of the hoop (which likewise may be simple or compound with the same proviso). Let P, P', and P'' represent any three simultaneous pressures that exist at these respective radii in the assembled gun.

By (13), Meigs-Ingersoll's Elastic Strength of Guns (1891) we have for the elongation of any radius r in the inner body (modulus of elasticity, E_1), caused by the pressures P and P',

$$\Delta r = \frac{r}{3E_1}\left[\frac{PR^3 - P'R''^3}{R''^3 - R^3} + \frac{4R''^3R^3(P-P')}{(R''^3-R^3)r^3}\right].$$

The extension or elongation of the exterior radius of this inner body (substituting R' for r) then is

$$\Delta R' = \frac{R'}{3E_1}\left[\frac{PR^3 - P'R''^3}{R''^3 - R^3} + \frac{4R^3(P-P')}{R''^3-R^3}\right] = \frac{R'}{3E_1}\left[\frac{5PR^3 - 4P'R^3 - P'R''^3}{R''^3-R^3}\right]. \quad \text{(a)}$$

The *compression* of the *diameter* is evidently the double of this with a negative sign, or

$$-2\Delta R' = -\frac{2R'}{3E_1}\left[\frac{5PR^3 - 4P'R^3 - P'R''^3}{R''^3-R^3}\right]. \quad \text{(b)}$$

Proceeding now to the hoop (modulus of elasticity, E_2); the elongation or extension of any radius r in its thickness is, by (13), Meigs-Ingersoll's Elastic Strength of Guns,

$$\Delta r = \frac{r}{3E_2}\left[\frac{P'R'^3 - P''R''^3}{R''^3 - R'^3} + \frac{4R''^3R'^3(P'-P'')}{(R''^3-R'^3)r^3}\right].$$

The extension or elongation of the interior radius of the hoop (substituting R' for r) then is,

$$\Delta R' = \frac{R'}{3E_2}\left[\frac{P'R'^3 - P''R''^3}{R''^3 - R'^3} + \frac{4R''^3(P'-P'')}{R''^3-R'^3}\right] = \frac{R'}{3E_2}\left[\frac{P'R'^3 + 4P'R''^3 - 5P''R''^3}{R''^3-R'^3}\right]. \quad (c)$$

The extension of the interior diameter of the hoop caused by the pressures P' and P'' then is,

$$2\Delta R' = \frac{2R'}{3E_2}\left[\frac{P'R'^3 + 4P'R''^3 - 5P''R''^3}{R''^3-R'^3}\right]. \quad (d)$$

The various simultaneous pressures that may occur in the bore, at the surface of contact, and outside the hoop simply move the surface of contact in or out. An increase in the compression of the exterior diameter of the inner body is accompanied therefore by an equal decrease in the extension of the inner diameter of the hoop (neglecting the very small, secondary, quantities caused by varying pressures upon the thin ring of metal whose thickness is half the shrinkage).

The shrinkage is the sum of the compression of the exterior diameter of the inner body and the extension of the interior diameter of the hoop (or jacket) and is (adding (b) and (d) and denoting the relative shrinkage or shrinkage per inch of diameter by φ),

$$2R'\varphi = -\frac{2R'}{3E_1}\left[\frac{5PR'^3 - 4P'R'^3 - P'R'^3}{R'^3 - R^3}\right] + \frac{2R'}{3E_1}\left[\frac{P'R'^3 + 4P'R''^3 - 5P''R''^3}{R''^3-R'^3}\right]. \quad (e)$$

This formula is true for any simultaneous pressures that may occur at the points indicated.

The shrinkage is most readily calculated by supposing the pressure in the bore to be the greatest the gun of given dimen-

sions and metal can stand, namely, the elastic strength of the gun. In calculating this, it is necessary to find the pressures at the various surfaces of contact. That is, using the book notation (Meigs-Ingersoll's Elastic Strength of Guns), in finding P_0, which acts at radius R_0 of the bore, we have had to find the pressures $P_1, P_2, P_3 \ldots . P_n$, which occur simultaneously at the respective radii $R_1, R_2, R_3 \ldots . R_n$.

Using these pressures and radii in (e), we have for the first shrinkage (assuming the modulus of elasticity constant throughout),

$$2R_1\varphi_1 = -\frac{2R_1}{3E}\left[\frac{5P_0R_0^2-4P_1R_0^2-P_1R_1^2}{R_1^2-R_0^2}\right] + \frac{2R_1}{3E}\left[\frac{P_1R_1^2+4P_1R_2^2-5P_2R_2^2}{R_2^2-R_1^2}\right];$$

for the second, $2R_2\varphi_2 = -\frac{2R_2}{3E}\left[\frac{5P_0R_0^2-4P_2R_0^2-P_2R_2^2}{R_2^2-R_0^2}\right] + \frac{2R_2}{3E}\left[\frac{P_2R_2^2+4P_2R_3^2-5P_3R_3^2}{R_3^2-R_2^2}\right];$

for the third, $2R_3\varphi_3 = -\frac{2R_3}{3E}\left[\frac{5P_0R_0^2-4P_3R_0^2-P_3R_3^2}{R_3^2-R_0^2}\right] + \frac{2R_3}{3E}\left[\frac{P_3R_3^2+4P_3R_4^2-5P_4R_4^2}{R_4^2-R_3^2}\right];$

for the n^{th}, $2R_n\varphi_n = -\frac{2R_n}{3E}\left[\frac{5P_0R_0^2-4P_nR_0^2-P_nR_n^2}{R_n^2-R_0^2}\right] + \frac{2R_n}{3E}\left[\frac{P_nR_n^2+4P_nR_{n+1}^2-5P_{n+1}R_{n+1}^2}{R_{n+1}^2-R_n^2}\right];$ (f)

and, if the n^{th} is the last, making $P_{n+1}=0$,

$$2R_n\varphi_n = -\frac{2R_n}{3E}\left[\frac{5P_0R_0^2-4P_nR_0^2-P_nR_n^2}{R_n^2-R_0^2}\right] + \frac{2R_n}{3E}\left[\frac{P_nR_n^2+4P_nR_{n+1}^2}{R_{n+1}^2-R_n^2}\right].$$

In calculating any shrinkage, say the n^{th}, if P_n is $(P_n)_\theta$ (that is, if this elastic strength is determined by the amount the inner circumference can stretch), the last term of the shrinkage is $2R_n\frac{\theta_n}{E}$; that is, the n^{th} shrinkage is

$$2R_n\varphi_n = -\frac{2R_n}{3E}\left[\frac{5P_0R_0^2-4P_nR_0^2-P_nR_n^2}{R_n^2-R_0^2}\right] + \frac{2R_n\theta_n}{E}.$$

If P_n is $(P_n)_\rho$ (that is, if this elastic strength is determined by the amount that the inner radius can be compressed), it is necessary to make the substitution in (f).

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

THE DUDLEY POWDER-PNEUMATIC GUN.

By HOWARD P. ELWELL, Associate Member U. S. Naval Institute.

Since the introduction of shell fire from the old smooth-bore guns the attention of ordnance officers and experts of every country has been constantly applied to the development of its effectiveness. Gunpowder was naturally first employed, but as the higher explosives were developed and became better known, unremitting efforts have been, and are now being made, toward obtaining some method by which they could be safely used in projectiles in order to obtain the object sought—destructive shell fire.

To obtain such results almost every conceivable scheme has been brought forward, involving either one or the other of two methods: first, of stowing the explosive by various means in specially contrived projectiles, the idea being to neutralize the effects of shock of discharge of the gun; or, second, by using some force other than ordinary gunpowder in the gun, which of itself would act gently instead of creating a shock on the projectile, thus insuring a safe discharge. An example of the first method would be the "Judson shell" and the means by which both the Army and Navy are able to load small quantities of gun-cotton and other explosives in projectiles fired from ordinary guns. A prominent example of the second method is the pneumatic gun, or "Zalinski dynamite gun," as it is more popularly known, where compressed air is used instead of powder.

In the first method the results obtained are much more effective than they would be with shells loaded simply with powder, but the weight of explosive used is necessarily, on account of the

shock to the projectile, but a very small proportion of the total weight of the shell.

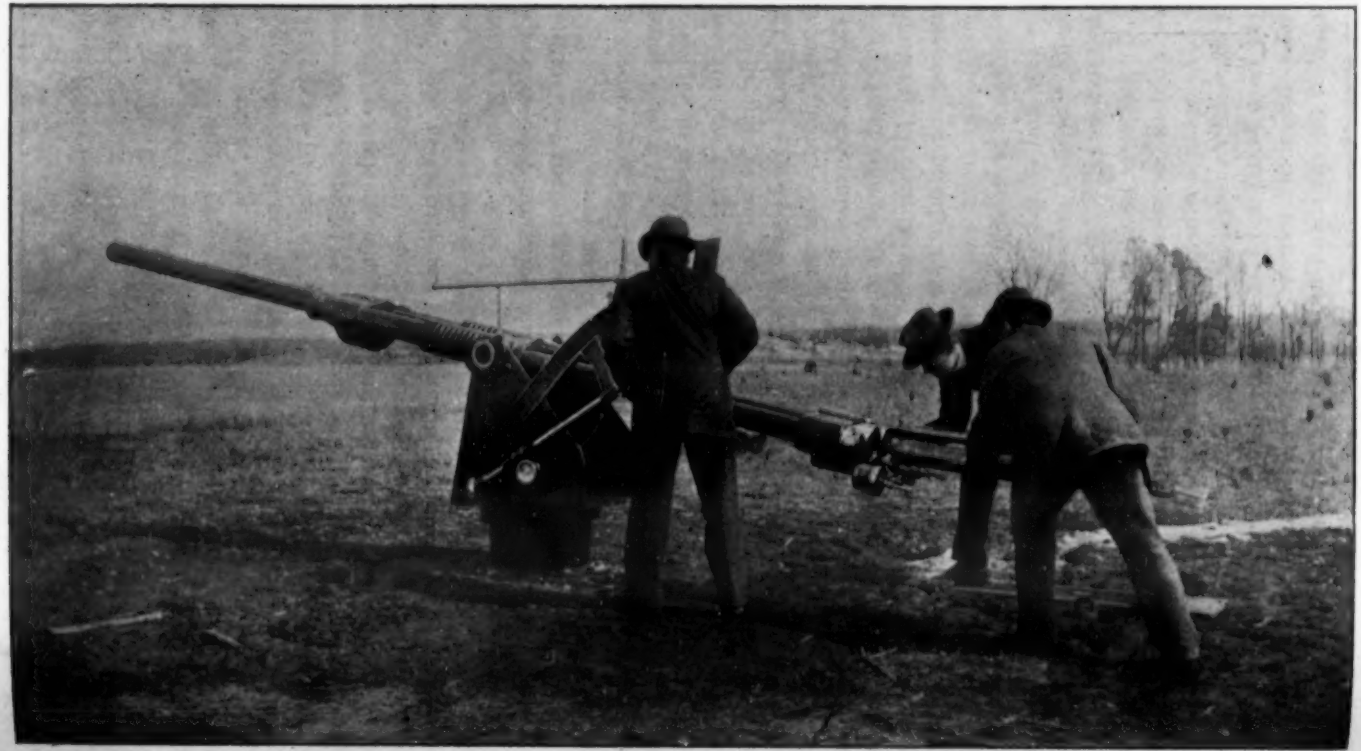
The second method is by far the most effective, as in this case very large masses of the highest explosive may be safely fired.

The ability to project these quantities of explosives with perfect safety and fair accuracy, together with the certainty of explosion at will, either on contact or with slight delayed action, is unquestionably of the highest importance. Favorable testimony to this effect from accepted authorities is so abundant and cumulative as to need no additional weight. So important indeed were the results obtainable by this method that a number of these pneumatic guns have not only been constructed and installed as a part of the defensive scheme for several important harbors—New York and San Francisco among them—but a special vessel, the Vesuvius, was designed and built as a "dynamite cruiser," carrying three such guns.

Some years ago the successes of these guns seemed to warrant the belief that they would become an important adjunct to coast defenses, as well as fill an important though distinct office afloat. For the past year or two, however, less and less has been heard of dynamite guns, and while to those not having knowledge of the facts the cause is unknown, it is really easily explained.

Without doubt the results obtained from this gun are as desirable as ever, and this being so, why has not the type been further developed and utilized? There is but one true answer to this—on account of complication in the system. Ordinarily in thinking of the question one simply has in mind the term—pneumatic gun. If the gun were complete in itself, matters would be comparatively simple, and in absence of complication would prove an effective and valuable weapon. As a fact, however, the gun itself, in this case, is but a detail of the whole necessary accompanying system. Without a steam boiler it is inoperative, yet the very mention of a boiler in connection with a gun brings immediately to mind the above-mentioned complications, for between it and the gun itself there must be necessarily a complex arrangement of air compressors, accumulators, pipes, valves and accessories, all of which require expert knowledge not only to assemble, but to keep in order and to operate.

In spite of all this complication the resultant value of the scheme is so desirable that this government encouraged the plan



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until it has become apparent that the many necessary mechanical parts and accessories involved complicate the system to such an extent that it cannot be depended upon.

It is undoubtedly true, however, that any scheme by which such desirable results can be obtained, and which is simple in construction and operation, will meet with general favor.

It is believed, and tests so far seem to prove, that in the Dudley system we possess all the required features with an entire absence of complication. This gun is as simple as an ordinary gun. It is an entirely independent unit, depending upon no outside accessories whatever. It is served, loaded, aimed and fired precisely as an ordinary gun, yet the force of the powder charge is so gently applied and cushioned that projectiles loaded with 60 per cent. of their total weight of the most violent and sensitive explosive are safely thrown to ranges far outside the limits required of such a weapon.

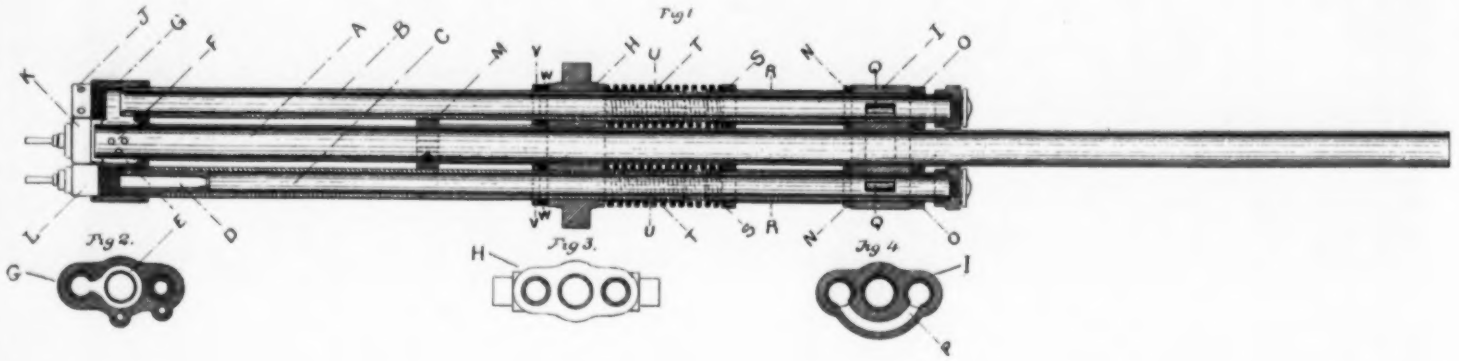
The description following is of a 4-inch gun, the subject of accompanying plates. A 6-inch gun would be on precisely the same design, an 8-inch gun practically the same with but slight changes in detail, but for 10-inch and larger calibers the design would have to be considerably modified.

The gun is built up of three tubes A, B, C (referring to Plate 7), placed side by side parallel to each other and in the same horizontal plane. The middle and longest tube is the main barrel. The two side tubes B and C together form an air chamber. The right-hand tube C is open at its rear end, in which is a steel bushing D chambered to receive a metallic cartridge case containing the powder charge. This tube is connected at its front end to the front end of the left-hand tube B, which in turn is connected at its rear end to an annular space E (Figs. 1 and 2) at rear end of main barrel. The main barrel has a number of holes F drilled through its walls connecting it directly with the annular space.

It will thus be seen that there is a clear, uninterrupted space between the powder charge and the projectile.

The tubes are held together and support each other by three gun-metal castings G, H, I (Figs. 1, 2, 3 and 4). The rear casting G is bored and threaded at its front end to receive the three tubes which are screwed in, forming pressure-tight joints in the case of the main and left-hand tubes. The rear of this casting

PLATE 7



CONSTRUCTION DRAWING.

is also bored and threaded in line with the tubes. A removable plug J is screwed pressure-tight at the left-hand. At the center a steel breech piece K, for the main breech mechanism, is screwed solidly to a shoulder. At the right is also a steel breech piece L for the side or powder mechanism.

The trunnion casting H is simply bored out to receive the three tubes, which are all fitted to slide freely longitudinally. To the rear of the trunnion casting is a small bronze casting M through which the main tube slides, as through the trunnion casting. It is fixed rigidly to the trunnion casting by four studs, and thus forms an additional guide for the tubes as they recoil, and also serves for attaching the elevating rack or screw.

The forward casting I is also bored for the three tubes. The main tube is fitted to simply slip into place, but has no fastening whatever at this point. The two side tubes being heavy and rigid in themselves support this casting and in turn support and stiffen the main tube, which, being much thinner, requires further support than given by the trunnion casting. The side tubes here have each two screw-collars, one at rear face of casting N, N, forming a shoulder, the other O, O, being screwed firmly against the forward face forms a pressure-tight joint, and also resists the full longitudinal strains of recoil. A port P (Fig. 4) is cored through the casting, passing under the main tube, connecting ports Q, Q, cut in the walls of the two side tubes.

A short piece of tubing R, R, having a screwed collar S, S, at one end, is slipped over each of the side tubes. One end abuts against the rear face of the collar, which forms a shoulder at rear of the forward casting. Between the screwed collar on the other end and the forward face of the trunnion casting is a spiral spring T, T, having sufficient resistance to compression to nearly absorb the recoil. Another short piece of tubing U, U, is slipped over the side tube under the spring, just forward of the trunnion casting, to limit the amount of recoil.

At the rear of the trunnion casting a collar V, V, is shrunk-locked to the side tubes, and between it and the casting a rubber ring W, W, is interposed to cushion the counter-recoil.

The side tubes are of 3-inch double extra strong commercial wrought-iron tubing. The construction as described is such that all longitudinal strains are taken by them. The main tube is of drawn brass, and being secured at one end only, is free to expand or contract, but is entirely free of all but bursting strains.

SIGHTING.

The side tubes are each provided with removable caps at the forward ends. These being removed, the plug at J and the two breech mechanisms being opened, the three tubes are clear for inspection and cleaning if found necessary.

The two breech mechanisms are of the slotted-screw type, the main provided with a gas check, that for the side or powder charge with hammer, mainspring, extractor, etc. Closing the block cocks the hammer, and a simple safety device is so arranged that it is impossible to fire until the block is completely locked.

The gun shown in the photographs is on a center-pivot carriage, but it is as readily mounted on a field or siege carriage for easy transportation, or on any other type of carriage, as it is entirely independent, the same as ordinary guns are.

On the mount shown the elevating and training gears are so arranged that the training shaft passes through the hollow elevating shaft, the two hand-wheels thus being on the same center, one just above the other. The shoulder piece attached to the left bracket of the carriage has a bearing for the shafts. The hand-wheels are thus brought so conveniently together that they may be worked by the left hand, while the right is free to hold and pull the lock lanyard.

The mount has otherwise no special features except the sight. This is so arranged that the directive element is entirely separated from that for elevation. A long bar, having a fixed front and a short vertically slotted rear sight-piece, is supported parallel to the axis of the gun, on one end by a rod to the trunnion bed of the carriage, the other at the shoulder-piece on a short slide adjustable at right angles, to provide correction for windage. These sight-pieces are fixed horizontally, so that the eye has the object constantly in view. The proper elevation is indicated by a range-bar, the lower end of which is attached to and recoils with the gun, the upper part sliding through a guide pivoted by the side of the rear sight to the shoulder-piece. This bar therefore moves vertically with the gun as it is elevated or depressed, the exact elevation being at once indicated by graduations on the bar reading against the top of its guide.

The whole sight thus becomes automatic, that is, no setting is required, the elevation or any alteration being coincidently shown by the range-bar, the direction of target being constantly in view through the sight-pieces.

BREECH MECHANISM OPEN.

BREECH MECHANISM OPEN.

The standard weight of projectile finally adopted for this caliber is 32 pounds. The powder chamber is reamed for 3-pdr. rapid-fire cartridge cases, in which 14 oz. smokeless powder, as manufactured by Dupont for the 3.20 Army field gun, is burned. Other powders may be used, however.

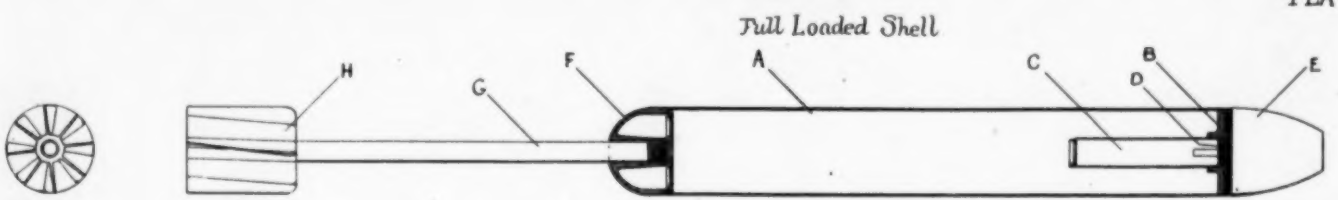
The body of the projectile (A, Plate 8) is of solid drawn brass, 4 inches outside diameter, No. 14 gauge, 26 inches long. The cylinder is threaded at each end on the inside for $\frac{3}{8}$ inch. A brass cap B having an internal thread is screwed in the front end to a shoulder. At the center of this cap is a thin brass tube C, $1\frac{1}{4}$ inches diameter, 7 inches long, projecting into the body of the projectile to receive the charge of dry gun-cotton. The inside of the front end of this small tube is threaded to receive a small cap-piece D containing the primer of 30 grains of fulminate. The head E of brass, constituting the body and containing the details of the safety fuze, is screwed into the cap. The body of the projectile is entirely filled with the explosive. The base F is an aluminum casting screwed into the rear of the tube. A tail-rod G of $\frac{3}{8}$-inch steel tubing is rigidly secured to the base and projects 18 inches to the rear, where a vane-piece H, of cast aluminum, is secured. This vane-piece has eight spiral vanes at a pitch angle of one turn in 84 inches.

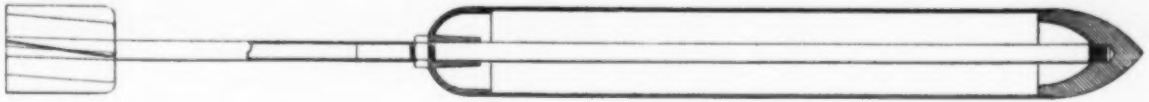
The weight of charge is 13 pounds, and may be of any explosive now known. Explosive gelatine containing 92 per cent. nitroglycerine has been repeatedly and successfully fired. There seems to be an almost utter absence of shock on the projectile, the force being applied more in the nature of a vigorous push rather than a blow.

The heat developed is not sufficient to be taken into consideration. After rapidly repeating shots, an ordinary tallow candle, slipped into a thin brass cup fixed in front of the gas-check in the main bore, shows no sign of melting. In fact, the bare hand can hardly note the increase of temperature on the inside of the bore immediately after firing.

The gun is remarkably uniform in action, and can be depended upon to group the projectiles within an exceedingly small space. The report of discharge is peculiar—not sharp, but rather muffled, and is actually so slight that a shot-gun can be heard much farther. There is absolutely an entire absence of smoke or vapor of any kind. There is no flame whatever in sight, and at night it can be repeatedly fired without exposing its position.

PLATE 8.





PROJECTILES.

By no means is it expected that this gun or system will replace any gun or weapon now in standard use, but it is believed that it has a definite place of its own and will be found valuable in certain cases where there seems to be at present nothing to fill the requirements.

Without entering upon any argument, a number of instances will simply be cited as examples where this gun would be found invaluable.

Afloat.

At the present time the only means of offense of torpedo-boats is the automobile torpedo. True, they are supplied with a number of small rapid-fire guns, but these are simply for defense against small-boat attack, signaling, etc. The very construction of such craft prohibits the mounting of ordinary guns of sufficient caliber to be useful for attack, not only on account of the weight, but for the reason that the shock of recoil on the deck would be much too great for vessels of this type.

At present, then, the effective fighting range of torpedo-boats is limited to the range of automobile torpedoes, or, in other words, assuming the boats to be armed with the largest and longest range torpedoes developed to date, something less than 800 yards.

A moment's thought will indicate the great increase of effectiveness of boats of this class that would result from the mounting of guns capable of throwing large charges of high explosive for distances of say 3500 yards, supplementing their automobiles.

To be more explicit, let us assume that boats of the 6, 7 and 8 class now building, boats of about 180 tons, were each provided, in addition to their designed outfit of torpedoes and 1-pdr. guns, with two 6-inch powder-pneumatic guns.

As now designed, when within 800 yards of the vessel to be attacked, either while approaching for the attack or while attempting to get away after having launched (unsuccessfully) their torpedoes, the boats would be absolutely powerless. With 6-inch guns of this type, however, they would be able to show fight up to 3500 yards, either while approaching to torpedo (if discovered) or while attempting to get away. Assuming such boats to have under these circumstances a speed of 25 knots, the time required to cover the distance between the range of guns and that of torpedoes would be three minutes, during which time it would be

BREECH MECHANISM CLOSED.

BREECH MECHANISM CLOSED.

possible to throw from the two guns at least 20 shots, each containing 50 pounds of the highest explosive. The probable chances of destructive effect from such a hail of bursting explosive can readily be conceived.

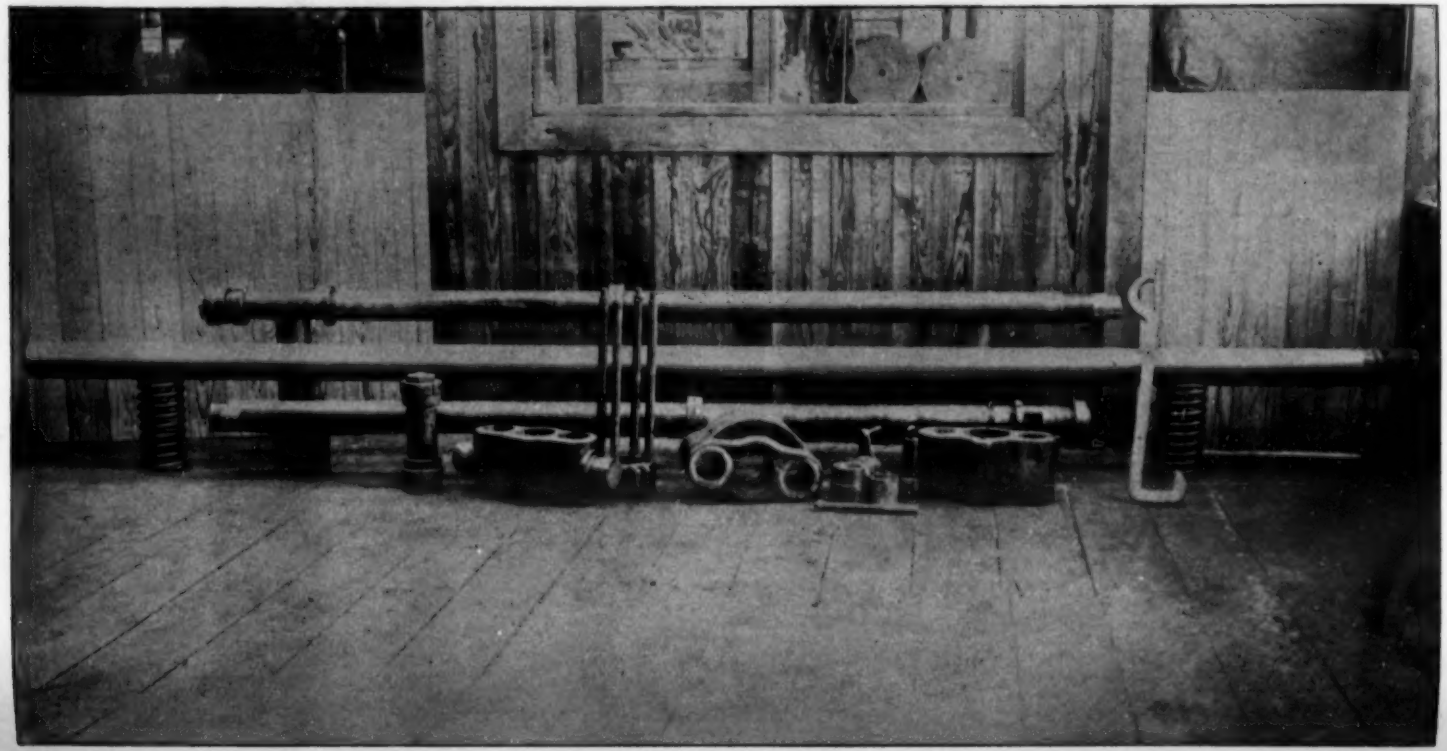
For countermining it is believed that this gun would prove particularly valuable, and far more effective than any known device; for this purpose, if for no other reason, one at least should find its place on every war vessel. When approaching waters where there is reason to believe that there are fixed mines, it will be possible by ahead fire to effectually clear the passage, destroying such mines by using shells fuzed for delayed action.

For auxiliary vessels, such as merchant craft, steam yachts, etc., that are likely to be pressed into service in case of an emergency, a battery of these guns would create a fighting strength far beyond that obtainable with any other type of gun that could be mounted on such craft. In this connection the light weight and absence of violent recoil would permit their being mounted without the necessity of strengthening decks, which would be absolutely required in mounting other guns, even of light caliber. The equipment of such vessels would thus be greatly facilitated.

Ashore.

The gun has evidently an important place in coast defenses both in large and small calibers. The great advantage in this case is economy, as well as effectiveness. There is no known weapon approaching its effectiveness which can be furnished and mounted ready for service for less than double the cost of one of these guns. It is an undoubted fact that no gun (excepting the so-called dynamite gun) is capable of throwing a shell so destructive in its effect in proportion to total weight. It is so simple in construction, and therefore so easily taken care of, with a positive surety of its being at all times in perfect condition for service, that but slight attention need be given it when once mounted. The slight report from these guns and the entire absence of smoke and flame would make it possible to mount them in exposed places, with little or no protection, and with but slight chance of their exact location becoming known to the enemy. Particularly would this be the case during a night attack.

For siege work the lightness of the gun and mount is of great



GUN DISASSEMBLED.

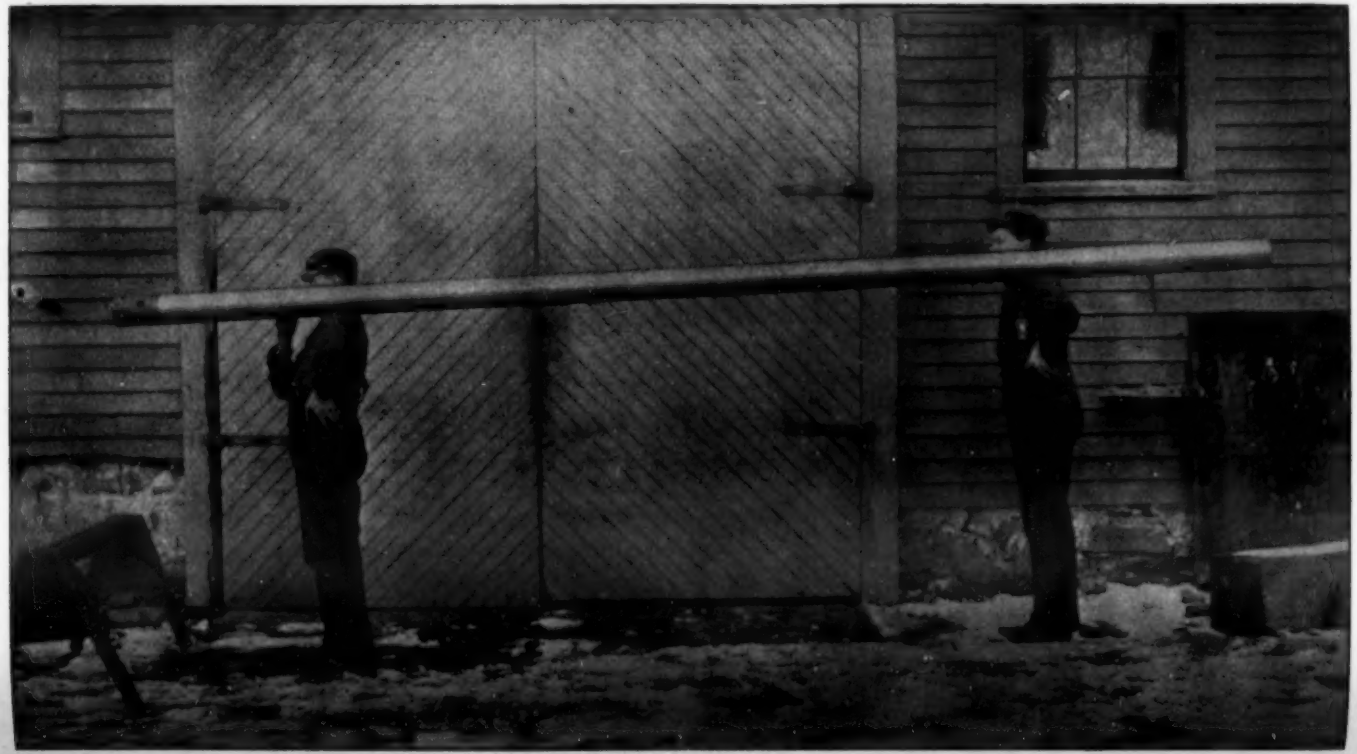
importance. It is readily possible to construct say a 6-inch gun of steel, weighing not over 3000 pounds, which will throw a shell containing 50 pounds of explosive gelatine to a range of at least 4500 yards. For this purpose the ease with which it may be dismounted, separated, and reassembled in the field gives it a peculiar advantage. The weight of the heaviest piece of a 6-inch gun would be 950 pounds (of a 4-inch it is 260 pounds). The practicability of transporting such a gun to localities and positions where it would be impossible to take an ordinary gun of equivalent effectiveness is of evident value. One single wrench and sledge-hammer are the only tools necessary to take it apart and reassemble, each operation being easily performed within an hour.

The 4-inch gun described weighs complete 1300 pounds, its mount 750 pounds. The gun has been fired about 200 rounds with full charges. It has functioned perfectly in every particular, the recoil easy, the breech mechanisms have worked well, and whenever attempts have been made at target practice remarkable uniformity and accuracy have been attained. Pressures have been repeatedly measured, and at no time, using same weight projectile and powder charge, has there been a perceptible difference. The limit of available range has been 2300 yards, and whenever desired this has readily been reached and could have been exceeded.

A number of full charges of explosive gelatine and also of gun-cotton have been fired, although most of the experiments have been with either dummy projectiles or for testing fuzes, with shells loaded with small charges of sporting powder.

This being the first and only practical gun built on this system, the action of the powder and in fact the whole principle being out of the ordinary, it is not to be expected that the best attainable results have been reached. So far as smoothness, easy action, recoil, and uniform action of powder is concerned nothing better could be desired.

Range of course depends entirely on the *amount* of force applied behind the projectile, and it will be seen that this can be increased simply by increasing the diameter of the side tubes, that is, increasing the volume of air-space between powder and projectile. Increase of this volume will permit the burning of more powder without *increasing* the *maximum* pressure.



HEAVIEST PIECE OF GUN.

The volume of air and gases thus increased, it is apparent that the pressure will follow the projectile farther in the bore, giving greater initial velocity. It is regretted that a series of actual pressure tests along the side and main tubes has not been made, although it has been the intention to do so. Such tests will be made, however, at the first opportunity. It is believed that with this data it would be quite possible to so design a gun of this caliber that the range would be doubled without danger of increasing the pressure beyond a perfectly safe limit for projectiles loaded with the most sensitive explosive.

Altogether this trial gun has given great promise, and there can be no doubt that it has demonstrated its value as a practical weapon.

It will perhaps be interesting, and at least it is but just to the original inventor, to give a résumé of the development of the scheme and credit its origin where it belongs.

The inventor, Dana Dudley, who deserves whatever credit is due, worked on the principle of which he was clearly the discoverer for a number of years, but was without the means to develop it properly. He had, however, made a gun of 1½-inch steam-pipe, which gave promising results and proved its feasibility.

In 1888 the Hotchkiss Ordnance Co. acquired control of the Howell torpedo, and soon after made a contract with the Navy Department for a number, together with the necessary launching-tubes. As no practical design then existed for the tubes, the question suddenly became an important one. It was thought necessary to use compressed air for launching, but the pipes for this in addition to steam pipes for the motor would have added to the existing complication.

The writer, who was then with the company working on the development of the torpedo, accidentally heard that Mr. Dudley had some sort of an air-gun. By request, Mr. Dudley showed and fired the gun, when at once it was evident that the scheme was applicable for launching-tubes. A temporary affair was built, and proving entirely satisfactory, the launching gear as now used by the company exclusively, and installed on several vessels in the Navy, was at once developed. No change has been made or found necessary in the application of the principle to that purpose, and this success led the writer to a firm conviction

of its value as a gun for throwing high explosives, which was the original idea of the inventor. No opportunity presented itself for working out the scheme until the past year. Now that a start has been made and the principle demonstrated on a practical scale, it is believed possible, with encouragement, to quickly develop the system until it takes its place along with the well-established standard weapons—the gun, torpedo, and ram.

Since the above article was written an official test has been given of the 4-inch gun before General Miles, the Board of Ordnance and Fortification, and Commodore Sampson, Chief of Bureau of Ordnance, Navy Department.

At this test 5 shells, each loaded with 13 pounds of explosive gelatine, were fired to sea, a distance of about 1900 yards, and exploded. These shots were perfectly satisfactory in every respect to all present. They were all that could be desired, being straight, true, steady and uniform in flight. Unfortunately, just afterward, during the practice at a target, the main tube was ruptured by the explosion within the bore of a shell loaded with 5 pounds of blasting powder. This accident, while putting an abrupt close to the tests, did not in any way count against the gun, as it was due to circumstances in no way related to the action or principle of the system, but was clearly due to a faulty fuze exploding the charge; and the result, so far as destructive effects are concerned, would have been much greater even had the shell been in the bore of say one of the service steel guns. The fuze was not one of those employed in the explosive gelatine tests and which so thoroughly proved their safety qualities, but one of entirely different design, made with a view of simplifying the construction. It is hardly necessary to say that this fuze has been condemned for future use.

Accidents of this kind generally and naturally serve as a check to the development of a new scheme, but it should be remembered *that it was not the gun which exploded.* It was a shell in the bore, and there are numerous parallel cases with ordinary guns and with corresponding results on record.

It was simply unfortunate that the accident happened at this stage of development and under the circumstances.

DISCUSSION.

THE ORGANIZATION, TRAINING AND DISCIPLINE OF THE NAVY PERSONNEL AS VIEWED FROM THE SHIP. BY LIEUT. W. F. FULLAM, U. S. N. (See No. 77.)

P. A. Engineer WALTER F. WORTHINGTON, U. S. N.—I have read the essay under consideration with great interest, and think it fortunate for the service that discussions of this kind should take place before the Naval Institute rather than in the public prints.

The author is to be congratulated on handling this subject in such a calm and dispassionate manner, and the conclusions he arrives at agree closely with my own in a number of particulars. His frankness and plain-spoken manner encourage me to believe that a similar frank criticism on points where we differ will not be taken amiss.

With regard to promotion by selection, it is generally admitted to be desirable if practicable. It would be wholly practicable to have the selection done by a board of senior officers. These would not be influenced by personal feelings if there was a general system of holding each senior officer strictly responsible for the work of his junior. Self-interest would compel him to select for promotion those found most successful in accomplishing the work assigned them. That system works well in the selection of enlisted men for promotions to positions as petty officers. Petty officers so selected on one ship are generally found to give satisfaction on other ships.

With regard to the statement that "there are too many line officers afloat," he says that it has proceeded from careless consideration, ignorance or malice. I maintain that the statement may have been made after careful consideration, in perfect good faith and with the best of motives. In the first place, the English ships, class for class, carry fewer line officers than ours and are well organized and efficient. In the second place, there are many line officers in our Navy who freely state that the deck watches in port and many minor drills and duties now performed by commissioned officers could be performed by warrant officers, as they are in the English navy. Thirdly, if enlisted men could hope to do more responsible duties they would be encouraged and more likely to reach that higher state of efficiency which the essayist himself justly says is so desirable.

It may well be that the presence of so many line officers on shipboard leaves too little duty to be entrusted to the petty officers. The constant presence of a commissioned officer on deck may make the petty officer feel that he is not trusted. To this cause more than to the presence of the marine sentry may be due that feeling of irresponsibility which we all deplore in our petty officers.

With regard to the necessity for so many officers to control the guns in different compartments, we who spend half our lives at sea know very well that the working of a modern gun is quite within the comprehension of a warrant officer, and the thought that by working it well in action he could get a commission would, in my opinion, be a sufficient stimulus to the patriotism which warrant officers possess as well as others.

It would be a bad system to maintain in time of peace a large force of officers to supply the needs of war. The Navy for the last twenty years has had an excessive number of officers compared with the number of ships, and we all know, and have all heard officers acknowledge, how rusty they get for lack of sufficient sea service. The enlisted men must be trained up to fill vacancies caused by war, and the naval militia developed to the utmost for the same purpose.

The essayist appears to me to confound two problems: one, to work a ship with the present inefficient petty officers, and the other, to work a ship with efficient petty officers.

The real function of the highly trained and educated officers graduated from the Naval Academy is to act as instructors and directors of the work of the higher grades of petty officers, who in turn should be required to instruct and control those below them, and so on. It is a waste of good material to have educated officers teaching the rudiments of ship's duties to landsmen and to personally supervise such work as sweeping decks. It is a singular thing that all this did not occur to the essayist, who has given so much thought to the subject of reducing the number of staff officers. If the system of turning over the bulk of the duties of the ship to petty and warrant officers was found efficient and advantageous, it would undoubtedly be adopted in the engine department, for the conditions are closely analogous.

Under existing conditions the system would be more likely to succeed with the line branch of the service than in the engine department, for the reason that in the former branch a large proportion of the petty officers have had years of training in naval vessels, whereas in the engine department by far the larger proportion of the higher grades of petty officers are taken in directly from civil life. For example, one ship was recently commissioned and sent immediately out to a foreign station. Three-fourths of the machinists provided to take charge of engine-room watches had never done such duty or served in the Navy before, and two-thirds of the water-tenders assigned to take charge of the watches in the fire-room had never been to sea before. This state of affairs prevails to such an extent in the engine departments of our ships that it is daily becoming more common for chief engineers, men of high standing for professional ability, to be punished for neglect of duty or sent directly from their ships to hospitals.

In the general shaking up which would be caused by these changes we must not forget that the highly educated and trained graduate of the Naval Academy, line or engine division, needs some additional practical training on shipboard, and must have one cruise at least as officer of the deck or engineer of the watch.

The essayist's general idea of increasing the number of enlisted men who can reach the grade of warrant officer is good, and commissioned officers should make up their minds to accept a smaller proportion of the living space of a ship.

The idea of rewarding deserving men by giving them tours of shore duty at navy-yards is excellent. It would also have a fine effect on the enlisted men if they could think that the officers of a ship were going to look out for their welfare after the cruise was over. All the different grades of men in the engineer's force could be employed in work at the navy-yards, with advantage to the Government as well as to the men.

The principal objection urged against the marines is that they are not available to swell the numbers when all hands are called upon for special work, such as coaling ship, cleaning up after coaling, scraping bottom in dock, etc.

Outside of the United States the usual system is to pay for the coal to be delivered at the bunker scuttles. The coal merchants are always able to supply any number of laborers at a low cost. This system can be perfectly well adopted in the United States.

The best way to hoist coal aboard is with steam winches. Where on small ships they are not already fitted, they could be provided at little expense. The deck force then would have only the work of shoveling coal into the bunkers. This they can easily do faster than the engineer's force can stow it. Any dry dock can supply laborers to scrape the ship's bottom, and it would be cheaper to hire them twice a year for this purpose than to carry seamen whose wages would be double that of marines. With regard to cleaning ship, the deck force ought to be willing to do the whole of it, since their other duties have been so much lightened by the habitual use of steam launches in place of pulling boats, steam capstan, winches, etc., and the total abolition of all sail and spar drill and work about the sails and rigging. Merchant passenger steamers are kept clean with a much smaller force than is available on naval vessels.

Taking the foregoing facts into consideration, it would be a wasteful expenditure of money to hire seamen to do the duty now done well by marines and at one-half the cost. The marine officer is the logical consequence of the marine. Men develop best under officers who are not opposed to their presence on shipboard. If a marine officer is not fully occupied it is not because there is lack of work on a ship which he is quite competent to do.

Taking a general survey of the whole field, it is manifest that the system in the Navy for years past has been to avoid giving work to staff officers which they are perfectly competent to do, and to continually increase the duties of line officers, then to argue that the former are not needed and the latter overworked. It is always better to accomplish ends by a change of administration than a change of organization.

Having already trespassed so much on the space in the Journal, these remarks must be brought to a close without touching on many other

interesting points brought out by the essayist. I hope my silence will not be construed to mean either assent or dissent in these cases.

Lieutenant W. F. FULLAM, U. S. N.—The statements that the essayist —"a young man of no experience"—has been "unjust and unfair," has not been "honest," has shown "ignorance" and "an absolute lack of logic," and has appealed to "perverted facts" in treating the subject of naval reorganization "as viewed from the ship," may well be passed over with a good-natured smile in view of the many favorable comments by officers whose rank and experience entitle them, at least, to respect and courtesy in the discussion of a professional subject. And many personal letters from officers of all grades from admiral down, who for certain reasons preferred not to express their opinions publicly, might be offered by the essayist in further support of his arguments.

It is not surprising that some officers of limited opportunities for observation should fail to realize how small is the available working force in a modern ship's complement owing to absentees, vacancies, berth-deck cooks, the sick, and other causes. Such officers should not insinuate, however, that the executive excuses men who ought to work; and still less ought they to treat the matter with contempt and advocate that petty officers ranking with sergeants in the Army shall shovel coal while privates remain idle. When certain graduates of the Naval Academy state that the bluejacket has "barely enough drill and routine work to keep him from growling," and that we now have quite enough men to coal and clean ship, as shown by the fact that six of the "*slowest* and *laziest* men on board a merchant ship hoisted in, wheeled forward, and dumped into the bunkers 70 tons of coal in six hours," it is demonstrated that line officers of the Navy must treat the subject of the working force more seriously, because somebody is badly mistaken.

If extra sentries are needed now in coaling ship, it can be stated that no sentries whatever would be needed if the petty officers of the Navy were given the status of non-commissioned officers in the Army. Cases are known where the marine guard was sent ashore for target practice while the ship was being coaled, because the commander did not deem its presence necessary, and perhaps an officer who suggests the necessity of extra sentries in coaling ship may remember such an instance in his own experience.

It will be perfectly fair to regard the ship as a "floating fort" if we apply to the enlisted men on board the same rules as regards trustworthiness and military discipline and development that obtain in a fort that does *not* float, and if we put on board the kind of men who are most useful in a fort that really *does* float—the men who can best keep it afloat.

Conduct, court-martials and desertions should not be urged against the bluejacket, because in these particulars he shows up better than the marine. During a recent year the percentage of marines court-martialed was six times as great as that of bluejackets. During ten years, from 1882 to 1891 inclusive, *twenty-six per cent. of the entire marine corps*

deserted annually, and the total number of casualties was so great that the average term of service was less than two and one-half years.

It is not fair to the bluejacket to say that "naval history demonstrates the statement" that marines are necessary as a "rallying point in case of temporary break or disaster." Such was not the case at Fort Fisher, nor at other places where bluejackets have faced the enemy on shore. The latter, with the line officers, have always been well to the front—they have not been dependent upon the marines as regards "strategy" and "fire discipline."

To say that a "good sailor would be spoiled in making a poor marine" would be less correct than to say that a good marine would be spoiled in the vain attempt to make a good all-around man-of-war's man. The marine must be taught at least ten times as much as the bluejacket to bring him to the same condition of usefulness afloat. In some respects little is gained in the attempt to extend the field of the marine. For instance, the latter may be exercised in pulling boats, but the bluejacket usually hoists the boat in and out of its cradle and is given extra work in order that the marine may get an exercise, which, so far as it affects the efficiency of the ship, amounts to little more than play.

To say that the marine officer performs all the duties of a line officer, "except standing watch," may provoke a smile. The watch duty amounts to about five hours a day—it goes on like the brook, forever, night and day. But it is safe to say that, counting Saturdays and Sundays, the daily routine duties of a marine officer as "quartermaster," "ordnance officer," "officer of the guard," and "in charge of government property," do not occupy him more than two hours a day, and usually not more than one.

Foreign navies furnish more arguments against than in favor of marines afloat. England is about the only country that maintains a distinct and differently uniformed marine corps afloat. Her extensive foreign possessions make such a plan more reasonable. Many other nations have no marines at all, and the French "fusiliers" are seamen, uniformed and trained as such, who are given a little extra musketry instruction on shore. They are far more like our bluejackets than like our marines, and the officers in charge of them are line officers of the navy. It is ventured that they are in no sense superior to our bluejackets with the rifle nor at infantry drill. The French navy cannot be cited in support of the plan of maintaining soldiers on board ship.

And one of the English officers who is quoted by our marine officers speaks as follows: "My idea is that our marines should be analogous to this corps (the French fusiliers), and the officers take similar duties. Their naval training would also enable them *to be utilized for other work on board*. Instructed in navigation, and having taken part in the general routine of a ship, they would be qualified to take charge of a watch. *Their uniform should be adapted to the distinctively naval functions they would assume.* It is now purely military, *an innovation which is comparatively modern.*"

Plainly this officer advocates the French system, in which the marines

have practically become bluejackets. And still another distinguished English captain states: "*There is now no reason at all for employing on board ship men brought up and instructed as land forces, and yet such is the result of the present system of the training and discipline of the marines.*" In this we see in the English navy, as in all others, a decided tendency toward that "homogeneity" which a graduate of the Naval Academy declares to be a "snare and a delusion"! The proposition, therefore, to give the bluejackets and petty officers all military responsibilities and duties afloat is not only in accordance with the practice in most foreign navies, but it is only a short step in advance of the policy proposed by the most progressive officers of the English navy. Our own admirals and captains are fast reaching the same conclusion. An admiral writes: "It is now as absurd to employ marines afloat as to employ bluejackets as a guard in a marine barracks." A captain who did not take part in this discussion says: "I formerly advocated marines, but my experience in this ship convinces me that they are now entirely out of place in a modern fighting ship." This is a result of a practical study of ship efficiency.

In concluding the discussion of the marine question, the writer regrets, sincerely, that there should be any ill-feeling engendered. But it is a matter of grave importance. No other so seriously affects the discipline and development of the bluejacket. Nothing so hinders the elevation of the man-of-war's man and tends so directly to keep the profession of a seaman beneath that of a soldier. The most bothersome incidents in daily ship routine and discipline, from the time "all hands" are called in the morning—at work, at drill, when boats are called away, and when the ship is cleared for action—are usually traceable to the direct, the indirect, or the moral effects of employing marines on board an American man-of-war. It is not a fad nor a fancy; it is an ever present influence which an officer who carefully studies the men cannot fail to recognize. And it is only from a feeling of duty to his men and to the ship, and after an intelligent consideration of the conditions existing, *and the conditions that are to be desired* in the United States Navy, that line officers have been gradually forced to the conclusion that efficiency in time of peace and in time of war would be greatly increased by making the fighting force afloat perfectly homogeneous.

Mr. Worthington's criticisms are so courteous as to merit acknowledgment, and they may well be regarded as a model. In carefully avoiding personalities, his arguments come with additional force, and a rejoinder will be required to upset them.

Granting, most willingly, that Mr. Worthington, at least, is actuated by the "best of motives" in saying that we have "too many line officers afloat," it is submitted that statistics of our own and foreign navies, and considerations of *war efficiency*, will not sustain him in this opinion.

Counting available ships, there are ten line officers per ship in the United States Navy. The computation for the navies of England, France, Russia, Italy, Austria, and Germany shows an average of seven sea-going line officers per ship. In addition to these sea-going line

officers, however, there are, in these navies, 2890 officers employed on shore at naval schools, naval stations, and in hydrographic, coast survey and other work which is performed by the line officers of the United States Navy. Taking these into account, there are ten officers per ship—as many as in our Navy—employed in doing line officer's work in foreign navies.

Now, even if we regard the line officers employed in naval work on shore as a *reserve*, it may be shown that such a reserve, of all others, *is vitally necessary in our case*. With the addition of the proper number of torpedo-boats to our Navy—which is sure to come in the near future—and the assignment of *one* line officer to each of them, we would not have in time of war, when auxiliary cruisers are commissioned, more than five line officers per ship to meet an enemy! This will be too few, when we consider the work involved in quickly training a large number of recruits and in preparing to defend an extensive coast with scant material. With fewer ships, more raw recruits, and a more extensive coast than our probable enemy, we must not be caught with fewer trained officers. Economy, and every consideration based upon an intelligent study of the necessities of war, demand that the United States Navy should have at all times a surplus of line officers. A competent "general staff" assigned to the duty of preparing this country for the emergency of war would be sure to arrive at such a conclusion. At present the surplus, if such it may be called, is very small. If all the ships of the regular Navy were now commissioned, 75 per cent. of the line would be at sea. In time of war the officers of the retired list could do most of the shore duty; but, making all allowance for them and for available graduates of the Naval Academy now in civil life, the Navy would be hard up for line officers in the event of war.

England has fewer line officers than most other navies—too few in the opinion of many of the best authorities in England, one of whom speaks as follows:

"The want of fully trained lieutenants and sub-lieutenants is a *fatal one*. The whole greatness of a navy, *all probability of success in war* depends on a sufficiency of young officers of the highest class, and yet we have allowed ourselves to look forward with complacency to picking up a sufficiency anyhow. The thing has grown on us so gradually that we are unable to realize the condition. We cannot see the absurdity of the very high and expensive training we give to a *small number* of lieutenants, when, if war breaks out, we must place them *side by side with officers of no training at all!* Even for peace manœuvres *we are seen to run immediately short*, and we are placing warrant officers who may be fathers of families in charge of torpedo-boats. Without any disparagement, it must still be said that torpedo-boat service is not for warrant officers. If this weapon is to do what is expected of it, it can only be when it is in the hands of the young and the daring. There are a great number of ships *which ought for the sake of efficiency* to carry considerable numbers of sub-lieutenants, and which do not carry one."

This picture of the conditions existing in the British navy, where the number of line officers is admittedly too small, should be a warning to us.

I think Mr. Worthington is wrong in arguing that we should reduce the number of line officers in order to develop the petty officer, and I cannot admit that he and others have found an inconsistency in the essay regarding its treatment of this subject. The petty officer can be developed by giving him, without reservation, the *exact status of a non-commissioned officer*—"only this and nothing more." To deprive him of this status, and then seek his improvement by reducing the number of line officers, would be as absurd as to give a corporal the duty of a commissioned officer in the Army while denying his ability to act as sergeant of the guard. Instead, therefore, of withdrawing line officers from ships and depriving the Navy of those officers who would be most vitally necessary in time of war, we should withdraw other individuals who are not needed, and remove other obstacles that prevent the development of the petty officer *in his own legitimate field*.

Line officers will not complain of watch duty if they are freed from the duties that are usually assigned to the non-commissioned officers in an army.

Executive and watch officers, who have the best opportunities for observation, will not agree with Mr. Worthington that steam winches, steam cutters, and the abolition of sails and spars have lessened the burden of ship-work. The following comparison of the complements of the Wabash and Philadelphia will serve to illustrate this point:

	Tonnage.	Total Complement.	Deck Force.	Engineer Force.	Marines.
Wabash	4500	540	385	44	49
Philadelphia . . .	4300	368	161	90	36

From this it will be seen that the *deck force* of the Wabash was greater than the *total complement* of the Philadelphia. The deck force of the Philadelphia *is considerably less than one-half that of the Wabash.* Line officers who compare the new ships with the old, and who remember their experience in directing ship-work, know that, regardless of steam winches, etc., the burden of drudgery and coaling ship is far heavier upon the individual man than in former days. There are many more drills and exercises, and the line officer and bluejacket are kept far busier now than in the days of the "old Navy."

It is true that the "working of a modern gun is quite within the comprehension of a warrant officer"—or even of a petty officer, if we consider the *mechanical question* simply—and we may grant that these subordinate officers are equally patriotic also. But there are other than mechanical questions involved in the control of guns and in deciding whether commissioned, warrant, or petty officers shall be in sole charge in battle. If the commissioned officer can be dispensed with in *some* of the turrets and in *some* divisions without loss of fighting efficiency, he can, for similar reasons, be dispensed with in *all*. As stated by the English authority, it is absurd to have officers of a very "high and expensive training" working side by side with officers of no scientific training at all. One or the other must be more efficient in control of

the battery. Let us consider two exactly similar ships going into action, one in which highly trained line officers have charge of the gun divisions and torpedoes, and the other in which warrant or petty officers have charge. Which would have the best chance of success? If the latter, then the Naval Academy may be abolished with little loss to the Navy.

If the control and direction of guns and torpedoes against an enemy were purely a *mechanical* question, like the control of an engine for instance, it is admitted that practical men like warrant or petty officers could do the work as well as commissioned officers and graduates of the Naval Academy. But there are tactical and military principles involved which require the presence of commissioned, highly trained officers in each turret and gun division, for the same reason that such officers are required in a company and platoon of infantry. The presence of such officers does not prevent the development of their non-commissioned subordinates. With the utmost good nature it is submitted that, to use his own expression, Mr. Worthington "appears to confound two problems"—one to work a ship and develop efficient petty officers by withdrawing line officers from ships, and the other to work a ship and develop efficient petty officers without depriving the ship and the Navy of the officers who are most necessary to fighting efficiency in time of war.

Mr. Worthington criticises the proposition to reduce the number of staff officers and replace them by line officers when practicable, and advocates instead an extension of the duties of staff officers. It would appear that the former proposition simply takes account of ship efficiency —*naval* efficiency—and that the latter takes account, primarily, of the *individual*. Now which is wisest and most economical from a naval point of view—to employ on board ship officers of no naval training and restricted usefulness, or officers of naval training and general usefulness? Which system would give the best results in time of war? All this *did* occur to the essayist when he proposed to replace officers and men of little or no naval training by others who are carefully trained. No offense was intended, no individual was to be injured—the "change of organization" was to be gradual, but it is absolutely necessary to the efficiency of the ship in time of war.

It is not easy to see that the plan of trusting petty officers on deck and withdrawing line officers would be more successful than to trust petty officers in the engine-room and reduce the number of scientific engineers, though Mr. Worthington seems to think so. It is submitted that the presence of so many commissioned engineers has prevented the petty officers in the engine-room from getting warrant rank. If petty officers and machinists in the engine-room have less service in the Navy than petty officers in the line, may it not be for the reason that they have less prospect for a warrant? Taking the five principal navies of Europe, we find that the average is 1.8 engineers per ship, while in our Navy the present number is 2.7 per ship, or as 2 to 3. We have, therefore, as large a surplus of engineers in our Navy as of line officers, in comparison with foreign navies. Is this surplus as necessary in the case of engineers

as in the case of line officers? Cannot the former be recruited from men in civil life more easily than the latter? Is it as difficult to find men who are acquainted with steam machinery as it is to find men who are acquainted with guns, torpedoes, naval tactics, etc.? There is nothing offensive in these questions, nor in the statement that the care and management of steam machinery does not require a distinctively naval training. It is only fair to say that the officers who run the engines of Atlantic liners and merchant steamers generally can run the engines of a man-of-war. Is it fair to say that the deck officers of a merchant steamer are competent to handle and direct guns, torpedoes and ships in a naval battle? Does not this duty require strictly naval training?

The same principles apply to petty officers—those who are to be efficient with guns and torpedoes must have naval training, while a machinist may be perfectly competent, as such, who has never seen a man-of-war. The same rule applies to engineers and machinists as to surgeons and apothecaries—all may be easily recruited from men in civil life.

It is to be regretted that Mr. Worthington did not give more space to the discussion of the engine-room personnel. It would be interesting to know if he advocates the increase of the engineer corps to 303, the assignment of engineers to colleges, and the appropriation of money to provide engineering plants for technological schools throughout the country in order that these institutions, probably thirty or more in number, might furnish about *seven* cadets annually for the Navy! Would it not be better to expend all this money and talent upon the Naval Academy course, where there is already a modern ship and some facilities for practical instruction, instead of attempting to build up thirty or forty schools of naval engineering? The writer believes that there are at least a few naval engineers who object to an increase of the corps which would sentence them to do the duty of a machinist for years, and that they would prefer a system in which the engine-room watch is stood by warrant officers and chief machinists, while the scientific engineers, few in number afloat, superintend the machinery. Line officers do not urge this plan on personal or corps grounds, or by reason of any feeling of jealousy or enmity. They, as the officers who must command the *whole ship*, believe that with the promise of warrant rank, shore service after a term of service afloat, and the retired list, a corps of most efficient mechanical engineers could be formed, thus relieving the college-bred engineer from the performance of duties that will always be uncongenial to him.

In conclusion, the writer insists that the essay was written with but one idea in view—to advocate what is best for the ship *as a man-of-war*. So far from being actuated by selfish motives, it is ventured that the watch officers of the Navy would, as a body, prefer to remain such all their lives rather than accept promotion as a result of compromises or measures that sacrifice the Navy as a military organization, and the ship as a fighting machine, in order to promote the interests of corps or individuals. We will continue to "plank the deck" and attend to every detail in ship routine rather than purchase advancement at such a cost.

Standing watch is an excellent thing in many ways; it keeps the "young" line officer in good physical trim and prevents his getting soft and flabby! In time of war he must have endurance. In time of peace he must prepare for war. Relieve him from a non-commissioned officer's duty and the line officer will attend to the watch and the legitimate duties of a commissioned officer.

The necessity for naval reorganization is pressing. It is annoying, to say the least, that the admirals commanding our most powerful squadrons, and the captains commanding our modern ships—even those within easy reach on the home coast—*should not even be consulted in framing measures affecting naval efficiency!* These officers, who study the whole problem of fighting efficiency—the only officers who do study it, the only ones who know about it—and who have kept these ships ready for war for months past, are ignored! The ship and the man who commands it are forgotten while "bills" are being framed in Washington! *But the ship and the man who commands it always decide the issue of battle.* They are not forgotten then. They should not be forgotten before the battle begins. If the Navy is to be reorganized in a manner to increase, *not lessen*, the chances of victory, Congress must think of the ship and respect the advice of the man in command, otherwise our Navy will be ruined by legislation.

Speed Control in Modern Steamers. (See No. 77.)

R. H. Thurston, Director Sibley College.—The general idea of Lieutenant Wood, as a matter of engineering, is, I have no doubt, perfectly feasible. I think that there is no serious difficulty in securing control of the speed, and of the operation of the engines, of a ship at any point on the vessel at which it may seem desirable. Difficulties will undoubtedly arise in the practical application of that scheme; but they will be overcome, it may be safely assumed, by a little ingenuity and skill in designing. In fact, the plan has been frequently proposed in the management of steam ferry-boats; where, if anywhere, that promptness of action and celerity of adaptation of the speed to the exigencies of the moment, which is important in the case of a naval steamer in battle, is most generally illustrated. There can be no question that the power of handling the ship and of adjusting her speed, as well as her course, from a point directly under the eye, and within reach of the voice, of the officer conning the ship, when in action, can hardly be overvalued. The real question and the fatal difficulties, if such exist, come in the actual employment of the device, which, as matter of engineering construction, may be, as we will assume, a perfect success. I am inclined to think, however, that it will be practicable to overcome all difficulties if the right sort of a designing engineer should take them in hand, and that none will prove fatal.

In the regular working of the engine, once started, and in simple adjustment of speed within ordinary ranges of working, I see no reason why it should not be perfectly practicable to secure the desired changes

from the pilot-house; always provided the proposed changes of speed are not too great and too sudden to be met, with similar promptness, in the boiler-room, and when no danger is incurred of provoking heavy priming, such as is liable to endanger the engines and disable the ship. The real obstacles lie in the facts that, as ordinarily handled, the engines and the boilers are under the eye and hand of people stationed where they can see every variation of the steam-gauge, every change of water-level, and every symptom of derangement at the boilers, as well as every indication of the presence of water at the engines, and who can, at all times and instantly, secure communication between engine and boiler-rooms and give any required premonitory message in case of trouble or danger arising in either engine or boiler-room. To make the plan here suggested a working and a safe arrangement, it must include a system of, probably oral, communication to and from the engine and boiler-rooms which will permit the commanding officer to give ample warning of intended evolutions, and which will permit the officers in the engine and the boiler-rooms to freely communicate both with each other and with the officer at the conning point. It will also involve the arrangement of a prompt-working provision for detaching the reversing gear of the engines from the control of the distant operator of the apparatus, so that, in an instant, if priming or other accident threatens, the men at the engines or the boilers may instantly meet the emergency by shutting off steam or momentarily slowing the engines, and thus avoid what might otherwise prove to be the cause of disability or of the destruction of the ship.

Throwing open the throttle-valve and giving the engines full steam at full stroke is not always certain to give the ship full speed; instant closing of throttle and shutting off steam completely will stop the engines, but it may not secure the appropriate synchronous action of the boilers. The ship's engines being stopped, the opening of the throttle is not always the only action demanded to start them, and it may destroy them the instant starting occurs. Starting heavy engines is always a matter of serious danger if intelligent caution does not preside on the occasion. Bringing engines to speed must be cautiously done, and any considerable and sudden increase of speed is liable to introduce danger of disablement at the engines, at the boilers, or at both. Overspeed, whatever the occasion, involves the same dangers. Sudden stopping usually involves no special danger in the engine-room; it may produce serious, even fatal, results in the fire-room when no provision is made for ample warning. The occurrence of a hot journal in the engine-room, if no provision is made for the officer there in charge instantly taking control on the arising of threatening emergencies of these kinds, may result in loss of the ship, and is very likely, in any event, to cause serious injury to the machinery, if not to destroy its efficiency for the time.

These are illustrations of the kinds of difficulty which may be experienced in the endeavor to reach the result aimed at by Lieut. Wood. It is very possible that they may delay the employment of his and other

devices of this nature; but I have myself no doubt that, if found by experience desirable, they will come into use.

As to mechanism, that has been already provided, and substantially as here proposed, many years. The steam steering-engine of Frederick Sickels, now more than a generation in use for that purpose, was also, in principle, applied by him to the handling of the valve-gearing of heavy engines, stopping, starting and adjusting speed as required, and at a date but little later than that of his first patent on that apparatus. It has precisely the same principles of construction in either case, has very similar duties, and may be relied upon without apprehension to supply the means of application of the system here discussed in every case. It has been employed in fact in all very large engines from his time to ours, and when embodying the essential features of the original invention, the plan is always found satisfactory. The connection of its operating valve with the conning-point is, to the engineer, hardly more difficult than running bell-wires. It is just such a bit of work. There is no more difficulty in connecting the steam reversing-gear than the steam steering-gear; the two machines are, kinematically, identical, and are simply slightly different applications of the same invention, substantially as proposed by that inventor. No serious uncertainty exists on this score. Lieut. Wood's remark about its practicability, and the illustration by reference to the locomotive, are perfectly correct. In fact, the P. R. R. used a steam reversing-gear under the hand of the engineman for large engines a long time ago. I am under the impression that the essential details of the scheme have been long since invented and patented, but I have not had time to investigate that matter.

Regarding the conclusions of this paper—the avoiding of accidents resulting from misunderstandings; the substitution of a better system for bells; the quick working of the engines and prompt adaptation of speeds to momentary requirements and emergencies; the control of the engines when minor accidents drive the people out of the engine-room; the adaptability to any form of engine; the easy transfer from the old to the new system, and the reverse; and minor advantages—all these advantages may, I think, be fairly claimed for a successful installation of this sort.

The quicker working of the main engines brings with it, as has been seen, some new and resultant risks. The relief of the engine-room officers from their present steady strain is perhaps likely to prove less than is anticipated. They must be ready at any instant, not perhaps to act in response to signals, but to detect those dangers which are entirely beyond the ken of the man at the distant operating point, and to jump at any instant to the reversing-gear for the purpose of disengaging the "automatic" action and checking priming or meeting other suddenly perceived dangers—dangers which would not be usually likely to arise under the present system, when the engines are handled by men whose eyes, and especially whose ears, are ready to warn them when they are approaching the limit of safe operation. I am not sure but that on this point the advantages lie with the existing system; but I do not think these advantages likely to control.

All things considered, as stated at the opening of this commentary, from the standpoint of the designing engineer, the problem seems to me simple, and in fact practically long since solved. It is about as easy to arrange for the handling of the engines, however heavy, from any point on deck as from the engine-room platform itself. The real difficulties will be found elsewhere. Sickels solved the engineering problem thirty or forty years ago.

HORACE SEE.—No question has ever been raised as to the possibility of devising some way to reverse the propeller engine and to regulate its throttle-valve at the bridge or in the pilot-house of a steam vessel. There is no doubt it can be effected in a number of ways with moderate success, but there are obstacles which, with our present knowledge, seem unsurmountable.

The reversing of the engine and the regulation of the throttle-valve are not one and the same thing. They are different functions which cannot be very satisfactorily performed at the same time by one instrument. If this could have been done it would no doubt have been adopted long ago in the engine-room.

The reference to the locomotive as an example is an unfortunate one. The engine-master of the locomotive of to-day does not have to move a massive lever in the cab. It is only necessary for him to move a small lever, and the reversing engine, as in the case of modern steamship engine, does the hard work. The regulation of the throttle-valve is also a separate operation. It will be found that the engine-master has one hand on the reversing lever whilst the other hand is on the throttle-valve. It will also be found that he does not move each at the same time, also that the speed of movement is not always the same. If such is the manner of governing an engine with the drains and other appliances convenient to the operator, how does it seem likely that a much more complicated piece of mechanism can be operated by a single lever located at a point where its movements cannot be seen and where the drains and other conveniences cannot be handled to suit the conditions which come under the varying pressures of steam, revolutions of engine, etc.?

When the engines are controlled at the bridge or in the pilot-house it will have to be in a manner very similar to that now employed in the engine-room.

PROFESSIONAL NOTES.

NOTES ON THE CARE OF RAPID-FIRE GUNS AND MOUNTS.

By Lieut. John M. Ellicott, U. S. Navy.

Several of the following methods having been successfully used by cadets at the U. S. Naval Academy under my instruction, and others having been suggested to me by officers who have applied them on board ship, I believe a description of them may prove useful.

Overhauling and Filling Recoil Cylinders.

This should be done with great care before every target practice, or, if target practice is delayed, once a quarter; but if leakage is discovered at any time its repair should be immediate, and the cylinders should then be refilled.

Be sure that the filling end of the cylinder is not depressed.

An overflow from the filling hole is not a sure indication that a cylinder is full; neither is it safe to trust soundings with a rod, stick or straw. The liquid capacity of the cylinder of every gun should be ascertained and recorded. It would be well to stamp it upon the outside of the cylinder near the filling hole. This could be done as readily on board ship as in the shop. Before refilling, a cylinder should be drained, then the measured quantity of liquid it should contain ought to be gotten into it. If the full amount will not go in, there must be some foreign substance or an air cushion inside. If room is found for more than the registered quantity it is probable that the gun is not out to battery, or that a disc or spring has been left out in assembling, or that there is some leak.

The handle on the compressor screw for 4-inch cylinders is too short for sufficient leverage, and a monkey-wrench must usually be substituted. A ratchet-wrench with a handle about fifteen inches long should be furnished for the compressor screw-head.

To Run the Gun in and Clean the Slide Rails.

This can readily be done, especially when the recoil cylinders are empty, and it should be done before target practice, or once a quarter, or after any exposure to sea or wet weather, in order to make sure that the gun is not "frozen" in its slide.

Pass the bight of a rope under the breech in rear of the recoil cylinder (4-in. R. F. G.), or in rear of counter-recoil cylinders (5-in. and 6-in. R. F. G's), and take the ends over the cap squares and, with round

turns, around the front transom of the oscillating slide, keeping free ends long enough for easing away. Remove one spring from the recoil cylinder (4-in. R. F. G's), or one spring from each counter-recoil cylinder (5-in. and 6-in. R. F. G's), and replace and set up pistons, rods and nuts. Depress the breech of the gun to full extent, ease away on the free ends of the rope and allow the gun to run in against the remaining counter-recoil springs. It may be necessary to start the gun with a pinch-bar or small tackle. Clean and lubricate the slide rails thus exposed.

The breech of the gun will now have too much preponderance to be raised by the elevating gear alone. Four men with the aid of a capstan-bar in the breech of a 4-inch gun, however, can raise it until sufficient muzzle depression is obtained to let the gun run out to battery. The friction discs of the elevating gear should be slacked off while this is being done, or the gear operated to assist in lifting. If the discs are slacked off they must be set up again as soon as the gun is out. More men may accomplish the same thing with the 5-inch gun, but with the 6-inch an overhead tackle or a jack may be necessary. After the gun is out, the muzzle should be kept depressed until the counter-recoil springs are replaced.

To Remove Rollers and Clean Roller Path, Training Rack and Trunnion Seats.

Remove clips, securing clamps and apron, replacing all bolts and screws with a slight turn in the holes from which taken. Ship the ratchet-wrench and jack up with it until the rollers can be removed. Block up under the chase and breech of the gun with sufficiently heavy material to bear its weight, taking care to place the blocks under the breech far enough back for the ratchet-wrench to swing clear. Remove the cap-square bolts and back out the cap squares. Slack the clamp of the elevating gear. Remove and clean the rollers; clean the path and training rack. Replace the rollers according to their numbers in their proper scores in the spacing rings. Ease down the top carriage with the ratchet-wrench, leaving the gun resting upon the blocking, until the trunnion seats are sufficiently exposed to clean them. Clean and lubricate the trunnions and seats. Jack up the carriage again with the ratchet-wrench until the weight of the gun is taken; replace the cap squares; remove the blocking; ease down the gun and carriage; replace apron, clips and securing clamps, and set up the elevating gear.

The ratchet-wrenches furnished for jacking up the top carriage have sometimes insufficient sweep between the carriage brackets and will not pawl. This can be remedied by heating and bending the wrench handles until they swing in the widest space between the carriage brackets. They then perform their duty admirably.

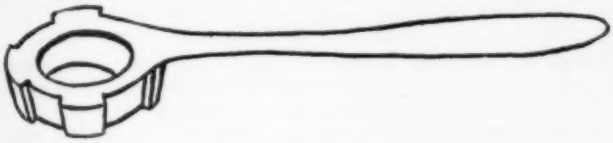
To Clean between the Gun and Recoil Cylinder.

With the 4-inch R. F. G., and with smaller calibers, the under surface of the gun lies so close to the upper surface of the recoil cylinder that moisture settles there and rust scale forms on the gun. When the gun screws into a sleeve it can be cleaned as follows:

Remove the sleeve-key set-screw and back out the sleeve-key. Unship the breech block. With a strap and heaver unscrew the gun a half

turn from its sleeve, bringing it bottom side up. Scrape, clean and repaint or repolish the exposed surface; screw the gun back again and replace the key and set-screw. Reship the breech block.

This is done to the 4-inch guns of the Essex without difficulty. By unscrewing the gun several turns and oiling the sleeve threads, it can be made to turn so easily that the gunner's mate can do it alone. Any ship's blacksmith could make a lever for this purpose having a socket bouching to fit into the screw-box, as shown in the sketch. With smaller rapid-fire guns a wooden heaver can be used in the breech block aperture.



To Overhaul the Training and Elevating Gear.

The chief precaution is to wedge pinions and worm wheels so that their slots are properly aligned for the keys on the spindles. Wooden mauls should be used in driving spindles home, or copper mauls as a last resort. The slightest burr or bruise should be filed from a key before it is replaced. When the vertical training spindle has been removed, with its pinion and bearings, it is well to remember that the training rack and much of the surface of the pivot stand is accessible through the hand-hole thus opened, if the gun is swung by hand through its full arc of training. In overhauling the training and elevating gear of the directing bar mounts for the 4-inch and 5-inch R. F. G's it is well to have their blue prints at hand until familiarity is attained, for their parts are so numerous and so combined as to be confusing.

To Sight the Firing Point of the Dashiell Breech Mechanism.

This is desirable when a miss-fire leads to the suspicion that the firing point is broken.

Open the breech; insert the blade of a screw-driver under the hook of the sear and bear outward, or hook the bight of a rope-yarn or of the lock-string under the sear hook and pull radially outward. At the same time pull the free end of the cocking lever away from the face of the block, and the firing point will be thrown forward and exposed. Press the cocking lever in, flush with the block again, before closing the breech.

What to do if the Dashiell Breech Block will not Unlock.

This may be due to a jammed cartridge case. See the breech fully closed, then insert the blade of a screw-driver between the projecting end of the extractor and the overhang of the breech-block rim, and press the extractor radially inward. Holding it thus, unlock and open the breech. The jammed case may then be removed by a hand extractor, or rammed out from the muzzle.

If this procedure does not permit the breech to be unlocked, the trouble will probably be found in the cocking mechanism. With the blade of a screw-driver between the sear hook and block rim, press the

sear outward as the hand lever of the block is drawn back, and the latter will usually revolve and swing clear. Then dismount the mechanism. The set-screw in the tapered nut behind the firing-pin sleeve will probably be found to lie in the wake of the sear partially unscrewed or with a burred head.

In " Description of Modern Ordnance " the sear is called the " releaser."

NEW DEVICE FOR SAILING SHIPS.

[The Steamship.]

An Italian sea captain is said to have made the extraordinary discovery that a ship goes faster when her sails are perforated with a number of holes than when they are quite sound. His theory was that the force of the wind cannot fairly take effect on an inflated sail because of the cushion of immovable air that fills up the hollow. To prevent this cushion collecting, he bored a number of holes in the sail, which let part of the wind blow right through, and allowed the remainder to strike directly against the canvas and exercise its full effect. Several trials have been made, and the results are so remarkable that it looks as if this is another of those paradoxical truths which appear so impossible on the surface. The experiments were made in all weathers. In a light wind a boat with ordinary sails made 4 knots, while with perforated sails she covered 5¼ knots; in a fresh breeze she did 7 knots with ordinary sails, and 8¾ knots with Captain Vasallo's invention; in a strong wind she did 8 knots and 10 knots respectively. If this increased speed were sustained throughout a long voyage it would increase the value of the ship one-fifth, as she would make the same trip in four weeks that she did before in five weeks.

THE BAZIN DISC WHEEL STEAMBOAT.

[The Engineer.]

Curiously enough, interest is being taken by French marine engineers in an experimental vessel now being constructed at the Saint-Denis Works of the Cail Company for a concern which was formed some time ago to work a so-called new system of propulsion of M. Ernest Bazin. It is hoped that this novel boat, which has already been in hand six months, will be launched in July next, and it will make its first trial trip across the Channel as soon after that date as possible. Writing on this subject, our Paris correspondent says: " Though at one time the *navire rouleur*, as it is called in France, met with a great deal of criticism among marine experts, who were rather sceptical as to the success of this new departure from the generally accepted ideas of naval design, it is significant that a fuller acquaintance of the theory laid down by M. Bazin has led them to place faith in the capabilities of the disc-wheel vessel. This theory is by no means a new one with M. Bazin, who has been working at it for twelve years or more, and an inspection of the models to be seen at his works at Levallois shows that the system has been applied in a great many different ways before the inventor was able to evolve the remarkable vessel which is now to be put to a prac-

tical test. It may be said that the first idea of M. Bazin was to apply a revolving motion to the vessel for the driving action in order to overcome the enormous waste of power due to the resistance of the water and the friction. As is well known, this resistance is proportional to the square of the speed of the vessel, and as the ratio of horse-power necessary to drive a ship increases enormously with the high speeds sought to be obtained, it is believed that the limit in the keel boats has almost been reached. In the problem which he has set himself to solve, M. Bazin believes he has suppressed the resistance of the water to the forward movement of the vessel, and in so doing he has not only added to the speed, but has secured, he says, great economy in motive power as well. To attain this end he designed a vessel in which a flat rectangular deck would be supported by hollow disc wheels of steel running upon their axes. Experiments were made to show the action of these wheels in the water, and in the presence of a large company they were repeated a few days ago by M. Bazin in a tank constructed for this purpose at his Levallois Works. First, a hollow wheel was placed in the tank, and it floated vertically with about a third of its bulk immersed. Spun round without any forward movement, the wheel continued to revolve for some time without moving from its place, and this proved to M. Bazin that he could not rely upon the revolution of the wheel alone for the propulsion of the vessel. He then pushed the wheel forward without revolving it, and the effect was exactly the same as with an ordinary keel, that is to say, it threw up a good deal of water in front and left a trail behind. Moreover, it only advanced four or five feet, and did not show the slightest tendency to revolve. This convinced M. Bazin that he would have to give to the wheel both revolving and a forward motion. Thereupon, spinning the wheel and pushing it forward, the hollow disc traveled the whole length of the tank with scarcely any agitation to the water whatever. Still pursuing the experiments, the inventor gave a more convincing illustration of the absence of any resistance and friction with the revolving disc. Two sticks were placed in the water, and a disc was propelled horizontally. On meeting the sticks the wheel pushed them forward a few inches and then stopped. Repeating this experiment with a revolving disc, the wheel passed over the sticks, which sank under the wheel and rose at the identical place, while the disc continued its course to the end of the tank. After thus proving that the wheel must have both a revolving and a forward movement, M. Bazin soon found that nothing was to be gained by revolving the disc too quickly, and that it was merely necessary to do this in proportion to the propelling force of the screw. If anything, too much power upon the wheels would be likely to cause a certain amount of friction. Under these circumstances, the relative power upon the propeller and the wheels would have to be calculated with a certain nicety, as the discs would have to turn in exact proportion to the distance covered by the boat. This fact having been settled, M. Bazin proceeded to demonstrate the stability and speed of the wheels. A framework carrying six disc wheels, three on each side, was placed in the tank. A cord was attached to it and drawn up over a pulley, and carried a weight of 200 grammes, which represented a certain propulsive force. The frame was pulled back to one end of the tank and allowed to go forward by the action of the weight at the end of the cord. According to the watch, the time occupied in traveling the whole length of the tank was twenty-three seconds. The same experi-

ment was then repeated with the wheels revolving by clockwork, and though losing two or three seconds at the start before getting up full speed, the apparatus went from one end of the tank to the other in eleven seconds. By comparing these results, M. Bazin estimates that the speed of a disc-wheel steamboat would be 31 or 32 knots, while the smaller power required results, according to his estimate, in an economy of about 66 per cent. of coal. One of the advantages claimed for the system is the practical impossibility of sinking. Supposing that one or two, or even more, of the wheels were perforated in collision, the vessel would not do more than sink a few feet, a fact which was exemplified by the inventor removing the plugs from two of the wheels and allowing the water to enter. As soon as the water had entered to a certain height in the wheel, it turned up with the orifice at the top, thus permitting of the damage being repaired with the greatest ease. Meanwhile, it would be possible for the vessel to proceed at reduced speed. Having thus, as he considers, demonstrated the speed, economy, stability, and safety of the Bazin wheels, the inventor showed a working model in a large basin constructed for that purpose. As the model is on a scale of one-twenty-fifth of a transatlantic boat, which it is proposed to build with a length of 130 m., the deck or platform represents a height of six or seven meters above the sea, while the upper deck is about 13 m. above the water-level. The deck itself is built up with girders, and being hollow, it has an enormous carrying capacity, either for merchandise or coal. There are eight discs or floats, four on each side, and owing to their convex form they offer little resistance to the wind, while the head wind has a clear passage underneath the deck. In appearance the model is very elegant, and certainly destroys any prejudice that might be entertained against the form of the vessel. The motive power was supplied by dynamos, one working the propeller and four others turning the floats. Upon the connection being made, the propeller revolved with great rapidity, and the wheels turned slowly, and after a few seconds lost in getting under way, the model sailed the whole length of the basin at great speed. To show the conduct of the vessel in rough weather, the water was agitated to represent waves, on the same scale as the model, of five to seven meters in height, and though rolling slightly at her moorings the model behaved splendidly when in motion. The miniature waves rose nearly to the level of the deck, but the model rode as steadily as in the previous experiments. It is claimed that in the roughest weather the passengers would feel very little movement of the vessel. In the experimental boat now being constructed the steering is done with an ordinary rudder, but it is proposed to steer the transatlantic vessels by means of a column of water forced out of the stern by a pump, so that instead of the progress of the vessel being impeded by the resistance of a rudder, it will be assisted by the water thus expelled at the stern. On the boat taking up its berth it may be driven by the steering gear alone, and this acts, it is alleged, so efficaciously that the vessel can be turned round in its own length.

"It may be added that Admiral Coulombeaud, one of the foremost naval authorities in France, is taking a keen interest in the Bazin disc-wheel boat, which he thinks is destined to effect great things in the water transport of the future. He admits having been sceptical as to the practicability of the system when it was first mooted, but after making a close study of the invention, he has fallen in with most of the ideas

enunciated by M. Bazin. After going to some pains in making a comparison between the *navire rouleur* and the ordinary keel boat, the Admiral has come to the conclusion that the Bazin boat requires only about twenty-seventh of the power necessary to drive an ordinary boat of the same size at a given speed. Taking the transatlantic Touraine as an example, he further states that if this vessel traveled at 20 knots, the disc-wheel boat, with the same horse-power, would attain a speed of 47 knots; but as it is not proposed as yet to construct a vessel to run at more than 30 knots, such a boat would only require a fourth of the power employed in the Touraine. His deductions also show that the power necessary for the floats is one-fourth of that employed for the propeller, and upon all the other points he is in accord with M. Parrot, professor of the Ecole Centrale, who has drawn up an exhaustive theory of the working of the Bazin boat. Admiral Coulombeaud does not believe that the present form of the disc-wheel boat is a permanent one. It will be greatly modified to suit the different conditions of transport, and this is especially the case with the floats, though for transatlantic vessels the present disc wheels could hardly be improved upon. The opinions thus expressed by some of the leading naval authorities in France give special importance to the trials that are to take place before long with the experimental vessel now being built, and if successful it is probable that a boat will be put in hand to run between Havre and New York. The following dimensions of the boat now building at the works of the Cail Co. may be interesting: Number of floats, 6; diameter of the floats, 10 m.; length of the boat, 39 m.; breadth, 12 m.; superficial area of the midship frame, about 50 m.; burden, 274 tons; power developed by the boiler, 700 horse-power, of which 550 horse-power will be upon the propeller and 150 horse-power on the axes of the floats. There will be a separate engine for the propeller and for each pair of disc wheels."

We have here history repeating itself. The boat on rollers is an invention as old as the steam engine.

TO PREVENT COLLISIONS AT SEA.

[Army and Navy Register.]

There has been favorably reported to the Senate and House a bill to amend the act approved August 19, 1890, adopting regulations for preventing collisions at sea. A few days ago the American delegates to the recent International Marine Conference met in Washington to consider proposed changes in the rules of the road submitted by Great Britain to this Government. The American delegates regard the suggested modifications as satisfactory, and so reported to the Secretary of State. With the report they submitted a draft of a bill which the President has transmitted to Congress. It is this which is now before the Senate and House with a favorable report. The bill provides that Article 15 of the act mentioned shall be amended to read as follows:

Article 15. All signals prescribed by this article for vessels under way shall be given: first, by steam vessels on the whistle or siren; second, by sailing vessels and vessels towed, on a fog-horn. The words "prolonged blast" used in this article shall mean a blast of from four to six seconds' duration. A steam vessel shall be provided with an efficient whistle or siren, sounded by steam or by some substitute for steam, so placed that

the sound may not be intercepted by any obstruction, and with an efficient fog-horn to be sounded by mechanical means, and also with an efficient bell. (In all cases where the rules require a bell to be used, a drum may be substituted on board Turkish vessels, or a gong where such articles are used on board small sea-going vessels.) A sailing vessel of 20 tons gross tonnage or upward shall be provided with a similar fog-horn and bell.

In fog, mist, falling snow or heavy rainstorms, whether by day or night, the signals described in this article shall be used as follows, namely: (a) A steam vessel having way upon her shall sound, at intervals of not more than two minutes, a prolonged blast. (b) A steam vessel under way, but stopped, and having no way upon her, shall sound, at intervals of not more than two minutes, two prolonged blasts, with an interval of about one second between them. (c) A sailing vessel under way shall, at intervals of not more than one minute, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam three blasts in succession. (d) A vessel when at anchor shall, at intervals of not more than one minute, ring the bell rapidly for about five seconds. (e) A vessel when towing, a vessel employed in laying or in picking up a telegraph cable, and a vessel under way, which is unable to get out of the way of an approaching vessel through being not under command, or unable to manœuvre as required by the rules, shall, instead of the signals prescribed in subdivisions (a) and (c) of this article, at intervals of not more than two minutes, sound three blasts in succession, namely, one prolonged blast followed by two short blasts. A vessel towed may give this signal and she shall not give any other.

Sailing vessels and boats of less than 20 tons gross tonnage shall not be obliged to give the above-mentioned signals; but if they do not, they shall make some other efficient sound signal at intervals of not more than one minute.

Sec. 2. That said act of August 12, 1890, as amended, shall take effect at a subsequent time, to be fixed by the President by proclamation issued for that purpose.

WOUNDS BY THE BULLETS OF MODERN RIFLES.

[Army and Navy Journal.]

Reports have been received at the War Department from military attachés of the United States abroad stating that in the Egyptian campaign the small-calibered steel-jacketed bullets from the high-powered rifles of the foreign troops fail to stop an enemy when he is struck. The failure in this connection is ascribed to the fact that the bullet, going with such high velocity, perforates quickly if it strikes a soft portion of the body, and for the time being does not sufficiently injure the wounded man to cause him to stop. Both the Navy small arm, just adopted for the naval service, and the Krag-Jorgensen rifle are of small caliber, the former of .236 and the latter of .30 caliber, and some army and navy experts have claimed that neither arm would be effective in instantaneously stopping an enemy unless he was struck in a vital spot. Brig. Gen. Flagler, Chief of the Bureau of Ordnance, has recognized that there might be something in this assertion, especially in view of the

results obtained abroad, and under his direction some experiments have been conducted with a view to securing a bullet which will stop an enemy if it strikes him. With the present style of bullet, the Krag-Jorgensen rifle can send a ball through three men at a thousand yards. With the change proposed, it will be impossible to obtain this penetration unless some improvement is found, which is being sought, which will give the same penetration as is now had. The change made consists in cutting away the steel point of the bullet so as to expose the lead core. It has been found that when a bullet so treated strikes an object it spreads out, and causes, consequently, a great deal more damage to the object struck than is now obtained with the bullet as it is now in service. Penetration is naturally required, and Gen. Flagler, in the experiments now being made, hopes to find some scheme by which the same penetration as was secured with the old bullet with greater destroying effects may be obtained.

Fort Riley, Kan., June 20.—An official test of the Krag-Jorgensen was made on dead bodies at post to-day under the direction of Dr. J. D. Griffith, of Kansas City, member of the United States Association of Military Surgeons and chairman of the National Committee on testing new guns, assisted by a dozen attending surgeons and photographers.

The object of the test was to find out the relative effects of the use of the Krag-Jorgensen gun, from a humanitarian point of view, as compared with other army rifles. This test has demonstrated to the minds of those who participated that the Krag-Jorgensen gun cannot be called a humane gun.

The three corpses to be experimented upon were placed side by side in an erect position just at the base of a hill, and a paper target was placed in front of each body to furnish a sight. Adjt. Scoll, 5th Cav., placed a detail of sharpshooters at a distance of 1000 yards, and then at 1500 yards. The firing was first by singles and then by volleys. Examinations of the bodies were made at intervals. Photographs were made of the wounds, showing as much as possible of their nature. The bodies were liberally perforated with bullets, nearly every organ and muscle being struck. Post-mortem examinations were made after the tests, and from them the following deductions were drawn:

At distances up to 1000 yards the explosive quality of the Krag-Jorgensen bullets, and consequently the cruelty of its use, is terrific. The explosive quality is most marked in soft tissues and cavities, the brain and lung tissues being terribly torn. When viscera are grazed by a bullet they are mutilated. Blood-vessels are cut, not torn; hence the death rate on the field will be very great—four killed to one wounded, probably. Tendons are the only tissues in the body which seem to be turned aside by the ball.

Further deductions drawn from experiments by firing into flesh and hard earth are as follows: Battles of the future will not be fought at artillery range. Any soldier can protect himself by the use of his bayonet as a pick. The best protection is loose, dry earth; next best, loose sand. Hard earth offers little resistance to bullets, which pass through from 16 to 20 inches of it practically without mutilation, whereas that many inches of fresh earth tear the bullet all to pieces.

ARMOR TESTS.

Test of an Experimental Turret.

[Army and Navy Journal.]

The experimental turret was tested at the Indian Head Proving Grounds on Saturday, May 9, and the results were in every way satisfactory. The test occurred in the presence of Secretary Herbert, chiefs of Bureaus of Navy Department and naval officers and members of the Congressional Naval Committees. The turret structure was almost identical with a turret on board the battle-ship Indiana. The ballistic plate employed was a 15-inch Harveyized nickel steel plate, manufactured at the Bethlehem Iron Works, put in position in that part of the turret that was to be fired at. Heavy cast-iron plates completed the turret, together with a heavy top. This armor plate had already been tested with two shots from a 10-inch gun.

The structure proper weighed 67 tons, the armor 157 tons, and there were inside of it 180 tons of pig metal to represent the guns, mounts, etc., a total of 404 tons. The whole was mounted on twenty radially placed cylindrical steel rollers, 10 inches in diameter and 30 inches long. Arrangements had been made for measuring any sliding, rotary or vertical motion of the structure. Before the first shot was fired at the improvised turret, a dog was placed within it to ascertain the effect the impact of a heavy shot had upon the inmates of the turret. The test was very severe, and was largely for the purpose of demonstrating whether the rollers on which the turrets are built would work satisfactorily under heavy shots, and also how the whole structure would withstand the shock. The structure withstood the impact of the heavy shells very well, and it is believed that heavy turrets, such as were represented to-day, will be all right under fire from heavy guns used in the Navy. It is feared, however, that the intermediate, or 8-inch turrets, would be disabled by shots from 13, 12, 10, or even an 8-inch gun, and it is possible that one shot from a 13-inch gun might knock such a turret over. The first shot was a Wheeler-Sterling shell, weighing 300 pounds, fired from a 10-inch gun, with a striking velocity of 1680 feet per second. It struck the plate 8 inches to the left of the normal line and 16 inches from the top. It penetrated 10 inches into the 15-inch plate and then broke up. The point of the shell welded into the impact. As a result of the impact the whole structure moved 1¾ inches to the rear in the line of fire. A triangular piece of plate weighing about 300 pounds was broken out above the impact. The supporting cast-iron plates were slightly wedged up. The turret seemed to be slightly sprung or elongated in the direction of the line of fire.

The second shot was fired from a 12-inch gun, a Wheeler-Sterling 12-inch armor-piercing shell weighing 350 pounds being used. It had a striking velocity of 1700 feet per second. It struck at an angle of about 3° to the right of the normal line, just below the middle of the plate. The shell broke, but the point remained welded in the plate. The plate was dished about 3 inches and cracked through from top to bottom. Many of the bolts used in fastening the plates together were started, but the structure as a whole did not seem to have sustained any permanent deformation.

In the third test a Johnson 12-inch compressed steel solid shot, fitted

with a soft steel cap and weighing 850 pounds, was fired with a velocity of 2000 feet per second. It struck in the left-hand upper corner of the plate, penetrated the latter and through the backing and a 2½-inch skin plate, a ½-inch maullet plate, and then broke. Some of the large pieces flew across the interior of the turret and cut through the skin plate and backing on the opposite side. The turret was moved handily to the rear about 16 inches. One result of this test was to show the good quality of this particular projectile.

The dog inside the turret gave no evidence of being any the worse for his novel experience.

In accordance with the orders of the Navy Department, Lieut. N. E. Mason, in charge of the Indian Head Proving Ground, made a careful examination of the experimental turret after its test. The first two shots had no appreciable effect on the turret. The Johnson shell, after getting through the plate, broke up, the largest piece entering through the covering plate on the rear side of the turret, piercing the backing and fracturing the rear cast-iron plate. The plate was forced in slightly on the target structure. The wooden backing in the rear of impact was carried away and badly squeezed and splintered. A portion of plating behind the backing was folded back and completely wrecked. The covering plates in the rear of the impact were twisted and ruptured badly, being split and bent back to a distance above the impact three feet to the left and two feet to the right. Portions of the channel beam forming the structure in the rear of the impact, three feet long, were ripped off and thrown to the rear, one portion landing on the opposite side of the turret and another being driven in the hole made by the head of the shell as it passed into the backing. The vertical covering plates directly in the rear and on the opposite side of the turret from impact contained eighteen holes and numerous deep gouges and other marks of flying fragments. The turret structure over an area of four square feet where the fragments struck was badly wrecked. A 15-inch cast-iron plate was badly cracked and wrecked, two large pieces of the plate being thrown to the rear. The report states that the turret structure as a whole shows no sign of deformation, either by measurement or examination. If a shell should by any possibility ever enter a turret on board of one of the battle-ships, the men inside would have small chance of escaping without loss of life or injury. It is very unlikely, however, that a shell would be able to strike a turret plate with 2000 feet per second, the velocity necessary to penetrate it, as the distance at which a battle would take place between two battle-ships would be about half a mile, while at the Proving Ground the plate was only 359 feet away from the gun when fired at. During the Chinese-Japanese war a turret was penetrated by a shell which caused terrible damage to the men and to the structure itself.

Test of Armor Plates and Projectiles.

An experimental shell burst in a 6-inch gun at the Indian Head Proving Ground on May 2, cracking the gun. Fortunately no other damage resulted. The gun was the one taken off the Dolphin and sent to the Proving Ground for experimental purposes some years ago. A shell carrying five pounds of gun-cotton and fitted with a Maxim fulminate detonator was placed in front of a charge of 45 pounds of brown powder. All the officers present retired to the bomb-proof and the charge was

exploded. Immediately afterwards was heard a rending sound. Fragments of the shell came from the mouth of the gun, and an examination of the weapon showed that it was cracked. In addition to firing this shell, there were also fired three 6-inch Johnson cast-steel shell, fitted with copper caps. The result of the experiment was very gratifying, and showed the excellence of the shell, as well as the value of copper for caps, it being the opinion of the experts that it gave as good results as soft steel. The first shell fired, with a velocity of 2100 feet per second, penetrated a 10-inch Harveyized plate. The bourrelet broke off and the remainder of the shell rebounded. Another shell of the same make and caliber, and also fitted with the copper cap, fired at a 7-inch plate at an angle of 20 degrees, broke up. The third shell was fired at the plate, impact normal, and succeeded in getting through and entering the butt.

At a trial of a 12-inch armor-piercing Carpenter shell at Sandy Hook on May 22, the shot, it is reported, penetrated 13½ inches of nickel-steel armor and six inches of oak backing, and was recovered from the sand uninjured. The shot demonstrated, it is believed, that the 16-inch gun need not be built at present. The projectile weighed 1100 pounds. The muzzle velocity and the distance are not given, but they were so regulated as to make the impact equal to a range of one mile.

A 12-inch and an 8-inch plate, which had formed parts of groups of armor manufactured by the Carnegie Company, and which had been rejected by the Ordnance Inspector on account of defects, were fired at at the Indian Head Proving Grounds on Wednesday, June 3. The primary object of the test was to ascertain what the shells could do against plates of the double-forged character. The most the 12-inch shell could do was to break off a corner of the plate, through the impact, and the 8-inch shells produced a back bulge. As a result of the trial, Capt. Sampson proposes to change the specifications for the ballistic test of shells for acceptance so as to give the manufacturers a greater chance of having their product pass the required trial. The 12-inch shell was a Wheeler-Sterling experimental projectile, and was manufactured under the contract entered into between the Government and the Wheeler-Sterling Company last November. It was given a velocity of 1800 feet per second and struck the plate in the upper right-hand corner, breaking off a section. It broke into fragments, but portions of the shell succeeded in getting through and fell behind the structure. Had this plate been supported by others, as on board ship, ordnance experts say that the shell would have done no damage, but would have smashed up on the face of the plate.

Two 8-inch shells were fired, one of the Wheeler-Sterling type and the other of the Carpenter variety. Both shells penetrated the plates several inches, producing a back bulge and breaking up, the bases falling in fragments in front of the structure. Capt. Sampson concluded, as a result of these tests, that it would be necessary to increase the velocity for firing 12-inch shells in acceptance tests from 1662 feet per second, for which the contract now calls, to 1850 feet per second, and for the 8-inch shell the velocity would have to be much higher in proportion. The experiments which are now in progress at the proving grounds are for the purpose of developing a temper in the shell which will perforate the double-forged armor. The results have so far been a complete victory for the armor, and speaks well for the character of plate on board our modern men-of-war.

In addition to the tests mentioned at the proving grounds, a sample of 6-inch smokeless powder was fired, which gave a velocity of 2600 feet per second. A bursting charge of smokeless powder was placed in a 6-inch shell and fired. The results showed that the smokeless powder had a greater bursting energy than the ordinary powder, but the advantage is not great enough to compensate for the extra expense in its manufacture to which the Government would be put in case it decided upon its adoption for this purpose.

An important test of armor-piercing projectiles occurred on Tuesday, June 16, at the Indian Head Proving Grounds. The shells fired included two 8-inch, one of the Carpenter and the other of the Wheeler-Sterling type, and two 12-inch, equally divided. The 12-inch shells were given velocities of 1900 feet per second each and fired against a 12-inch Carnegie Harveyized plate. Both shells perforated the plate and were recovered back of the butt in perfect condition. Each of these shells represented a lot of fifty projectiles, which were accepted upon the showing they made. In the case of the 8-inch projectiles, they were each fired with a velocity of 1800 feet per second against a plate of eight inches in thickness. Both shells penetrated the plate and broke up, fragments falling between the plate and the butt. These shells also represented lots of fifty each, and having met the requirements, the lots were accepted.

SHIPS OF WAR.

[The United States.]

The Massachusetts.

[Army and Navy Journal.]

The Massachusetts underwent her full-speed trial on April 25. The Board of Inspection and Survey has made a very flattering report on the battle-ship. It appears from the report that the time required for the Massachusetts to make the run of 31 knots over the Cape Ann course, in a northerly direction, was 1 hour 55 minutes and 58.97 seconds. On the return run over the course the time occupied was 1 hour 54 minutes and 24.47 seconds. The time occupied in making the total run of 62 knots was consequently 3 hours 50 minutes and 23.44 seconds. The total corrections applied to the trial course made the distance through the water 62.23571 knots, and the true mean speed of the battle-ship at 16.2079 knots per hour. "At the end of the return run," says the report, "the helm was put hard over both ways before the speed was materially reduced. The steering gear worked well, except as to the time of putting the helm over, which was, from hard a-port to hard a-starboard, 29 seconds." The board submitted these conclusions: That the vessel is sufficiently strong to carry her armor and armament, equipment, coal, stores and machinery; that the vessel, including hull, fittings, machinery, engines, boilers and appurtenances, etc., is strong and well built; that the machinery worked well, and its performance was in all respects satisfactory. The total weight of machinery is 896.39 tons, which is 21.39 tons in excess of the contract requirement. The board also states that the vessel is complete in all respects, with the exception of some work

which is of minor character, and which it points out in detail. "So far as the board had an opportunity of forming an opinion," the report continues, "the seaworthiness and general efficiency of the battle-ship Massachusetts are excellent. Her steering qualities in smooth water were tested, and leave nothing to be desired, except as to the time of putting the helm over." The Department has mailed to the Cramps a statement of the work yet to be finished, with instructions to push it as rapidly as possible, as the Department desires to place the battle-ship in commission as early as possible.

Included in the report of the Board of Inspection and Survey is a report made by Lieut.-Comdr. Seaton Shroeder. This report deals essentially with the ordnance features of the vessel. It states that the after turrets were turned while the ship was rolling six degrees on each side in the time noted, as follows: 13-inch turret, 38 seconds; starboard after 8-inch turret, 11 seconds; port after 8-inch, 18 seconds. The 13-inch turret turned noticeably faster when going with the roll and noticeably slower against the roll, but not to such an extent as to give any impression that the power would not be sufficient for a much heavier roll; there was no slipping of the friction clutch. The 8-inch turrets were apparently not affected in their motion by the roll. Lieut.-Comdr. Shroeder states that as at present stowed the stream anchors would possibly be torn from lashings when firing the after 13-inch guns with extreme train forward; there is also no means of handling them. From the after search-light control-stands the light beams cannot be seen striking the water when thrown more than four points forward of the beam. The neighboring 6-pdrs. and their crew will also seriously interfere with efficient service of these controllers. The best place for them would be on brackets outside the railing of the check-compass platforms aft, from whence a good all-around view could be obtained. The forward 8-inch turrets cut off the field view from the conning tower. If one peep-hole on each side were cut in the conning tower above the present ones, the horizon could be seen over those turrets through an arc of about 25 degrees farther aft on each side. At the speed between 12 and 13 knots, which causes the maximum vibration, the 13-inch guns of the Massachusetts did not vibrate in their mounts as did those of the Indiana. The signal topmast vibrates at times so badly as to endanger the truck-light. "The Massachusetts is a fine ship," the report concludes. "She rolls very little, except with the swell well aft, and under those circumstances her motion is naturally easy and regular. In shoal water, even when going slow, she squats some two feet. She turns readily with helm or screws, and can be safely handled in narrow waters. A helmsman not accustomed to a ship so broad and with such heavy ends is apt to have difficulty in steering a straight course; but in experienced hands she can be, and has been, steered very well in deep water."

The Brooklyn.

The Brooklyn left Delaware Breakwater and went to sea shortly after 9 o'clock Monday morning, May 11, for her builders' trial trip. She proceeded directly off shore about 75 miles to deep water. The run was made under forced draught, and consumed about three hours, during which time the cruiser developed a speed of 21.07 knots an hour. This speed was more than a knot greater than the contract with the Govern-

ment calls for, which requires that the Brooklyn shall average 20 knots an hour. The average revolutions of the screws were 132, and the steam pressure 155 pounds. The horse-power developed cannot be given, as the indicator cards have not yet been worked out. The performance of the engines was excellent. No stoppage for repairs was made. During the run not a bearing or journal became hot. The weather conditions for the trial were perfect. There was only a slight breeze from the southwest, and the sea was perfectly smooth.

The wonderful steadiness of the ship while being driven under forced draught was remarked by all on board. The fine lines of the hull were shown in the way the Brooklyn goes through the water when being speeded. There was no great bow wave, but the vessel threw the water to each side as cleanly as a knife cuts through cloth. A run was also made between the two lightships on Five Fathon Bank Shoal. On the first run, with the screws making 100 revolutions, 16.70 knots were made. At 115 revolutions 18.41 knots were logged, and at 124 revolutions, 19.75 knots were reeled off. The object of the trial between the lightships was to obtain data from which the builders can form some judgment as to the number of revolutions required to obtain the guaranteed speed of the ship.

As compared with the New York, the Brooklyn is of 670 tons greater displacement, measuring 9150 tons against the New York's 8480 tons. She is 400 ft. long, has 64 ft. 8 in. beam, and 24 ft. mean draught. She is armed with eight 8-inch guns—two more than carried by the New York—ten 5-inch guns, and sixteen 6-pounder rapid-fire and machine guns. She is protected by a complete steel deck, 3 inches thick on the flat and 6 inches on the slope, and by a water-line belt of 3-inch steel plate backed by a double thickness of hull plating over the whole length of the "vitals." Moreover, the 8-inch guns are protected by 10 inches and the 5-inch guns by 4 inches of steel.

The Oregon.

The report of the Board of Inspection and Survey on the trial of the Oregon states that the vessel, having been weighted to a mean draft of 24 feet, made her speed trial on May 14 in Santa Barbara Channel. The speed of the Oregon as observed by transits was 16.78 plus knots or nautical miles, made up of two runs over the course, the first from eastward to westward at the rate of 17.78 knots; the second from westward to eastward at the rate of 16.49 knots, giving an average of 16.78 knots. This speed having been corrected by the application thereto of the resultant tidal and current observations became 16.791 nautical miles, which is the speed of the Oregon. At 8.10, May 14, the engines having been given a preliminary warming-up, the Oregon crossed the eastern range of the course under full steam, and as obtained by careful observation, went at the rate of about 17.3 knots. As she ran to the westward a swell was encountered, and before reaching Point Conception the head wind was very fresh and the swell became a moderate sea, the water breaking over her bows as she pitched. Running a mile or more to the westward after leaving the course, the sea became quite heavy. The turn to the eastward was made with 7 to 10 degrees of the helm. She turned in a very small circle; the heavy sea, which when ahead had caused her to pitch from 1½ to 2 degrees, when it came abeam caused her to roll

very slightly—not over 2 degrees. A turn made in a more moderate sea has an estimated diameter of not over ten ships' lengths.

The report finds that the Oregon is sufficiently strong to carry her armor and armament, equipment, coal stores and machinery, and that the vessel is strong and well built. She is in all respects complete and ready for sea with a few minor exceptions which the board points out. One of these is mentioned as unsatisfactory berth protective deck plates, which, by telegram of the Secretary of the Navy, the board is authorized to consider as unfinished work.

"The board would state," the report says, "that in addition to the ordinary means by which during the short duration of the trial trip opportunity is given to form valuable opinion on all points including seaworthiness, we were furnished during our return from Santa Barbara to San Francisco with a fresh gale from the northwest which produced a heavy sea on the port bow. We were thus given an opportunity to watch the performance of the Oregon in a heavy sea. It is unanimous," the report says, "in pronouncing her an excellent sea boat—stable, easily steered, powerful, with remarkable freedom from vibration. Steaming 17 knots against a moderate head sea, or 7 or 8 against a heavy sea, her pitching was easy and there was no squatting, and the motion was that of a rocking-chair. There was no time during the trial that all of her guns could not have been efficiently served. We consider her a most excellent gun platform. The ship is remarkably free from vibration of hull—such as was observed is local. Going ahead full speed, 15 knots, the engines were reversed and the ship came to a dead stop in three minutes.

"In conclusion," the board says, "the board desire to express its opinion that the Oregon is in every respect a most efficient and formidable battle-ship, speedy and substantial, and that the United States is to be congratulated upon the addition of this vessel to its naval resources."

There is a strong probability that there may be a change in a part of the armament of the battle-ships Kearsarge and Kentucky. This relates to the 5-inch guns. The Ordnance Bureau is desirous of substituting 6-inch guns for the smaller type, and in any event, if the opinion of Capt. William T. Sampson, chief of the bureau, prevails, the battle-ships to be authorized at this session will have 6-inch guns as a portion of their main battery. The Kearsarge and her sister ship are to be armed each with four 13-inch, four 8-inch and fourteen 5-inch guns, besides those composing their secondary batteries. Capt. Sampson would like to have about ten 6-inch guns as a part of their armament. While before the Walker board, which is considering the question of armament for the proposed ships, Capt. Sampson made known his preference of 6-inch guns over 5-inch, and the board will consider the suggestion in connection with the other recommendations which it has before it.

Advocates of inclined turrets intend to make a strong fight for the adoption of their choice as features of the battle-ships to be authorized at this session of Congress. Chief Naval Constructor Hichborn has altered the model of the experimental turret recently fired at at the Indian Head Proving Ground from a vertical into an inclined type. With this design he proposes to demonstrate to the authorities the many advantages possessed by this type of turret over that now in service. This question will be raised in connection with the recommendations by the Walker board in its report on the armament for the new ships.

Under its recommendations the four 13-inch guns are to be mounted in pairs in two single turrets, one located forward and the other aft. It is these turrets which will be a matter of considerable discussion between the several bureaus of the Navy Department during the next few months, and in it the old question of the comparative value of vertical and inclined turrets will be revived.

Secretary Herbert gave out, in regard to the Walker report on the armament for the proposed battle-ships, a statement that "As a result of its investigations the board recommends a slightly different ship, with a somewhat different arrangement of battery, from any heretofore built. While speaking very favorably of the superimposed turret, as designed for the Kearsarge and the Kentucky, the board does not recommend installing more turrets of this description until experiments with the two ships named have demonstrated their utility. The hull of the ship recommended is that of the Kearsarge and Kentucky, but so modified as to be similar in many respects to the Iowa. The main battery recommended is composed of four 13-inch and fourteen 6-inch guns so arranged as to fire two 13-inch and four 6-inch guns directly ahead, two 13-inch and two 6-inch directly astern, and four 13-inch and seven 6-inch in broadside. The board also recommends that the normal draft upon which the ship's speed is based should be the fighting draft or the draft of the ship with at least two-thirds of her movable weights on board. It also recommends various minor changes in quarters and internal arrangements of the ship in the interest of the health and comfort of the enlisted men. It is believed by the Department that the ship outlined as above will be an improvement upon any yet built in this country. The Secretary of the Navy, after consulting with the chiefs of the Bureaus of Ordnance, Construction and Repair, and Steam Engineering, has approved the general features of the report of the board, and directed that the plans be taken up without delay. The contracts for all the vessels authorized in the new law, battle-ships and torpedo-boats included, will be made within the time prescribed in that act. The Secretary has already decided upon all the preliminary steps.

Battle-ships Nos. 7, 8 and 9.

The Secretary of the Navy has issued a circular calling for bids to construct battle-ships Nos. 7, 8 and 9. The limit of cost of each vessel, exclusive of armament, is $3,750,000. The ships are to be built in conformity with the provisions of the act of August 3, 1886, as to materials, engines, boilers, machinery, etc. No premiums are authorized in the appropriation bill providing for their construction. Under the act the contracts for the construction of the three vessels are to be made on or before October 8 of this year. The Department will invite proposals, either under its own plans and specifications or under plans and specifications submitted by the bidder and approved by the Secretary of the Navy. The circular gives the general features of the vessels. The length on the load water-line, normal displacement, is to be 368 feet; the molded breadth at load water-line, 72 feet; the mean draft at normal displacement, 23 feet 6 inches; normal displacement, about 11,500 tons; total coal capacity, loose stowage, 1200 tons. The battery will consist of four 13-inch guns, fourteen 6-inch rapid-fire guns, sixteen 6-pounders, four

1-pounders, four machine guns and one field gun. The complement of officers and men will be 490. The speed to be maintained at sea for four consecutive hours is to be not less than 16 knots an hour. The hull is to be of steel, not sheathed, with a double bottom and close water-tight subdivisions. There will be two military masts, with fighting tops. No sail will be carried. The protection of the hull against injury to the water-line region is to be afforded by means of a side-armor belt of a maximum thickness of not less than 16½ inches, and a mean depth of 7 feet 6 inches. The belt is to extend at least from the stern to the after barbette, and to maintain the maximum thickness throughout the engine and boiler spaces. From thence forward it may be tapered gradually to a uniform thickness of 4 inches.

The transverse armor at the after end of the belt and just forward of the boiler will be not less than 12 inches in thickness. The barbettes for 13-inch guns will have armor 15 inches thick, except in the rear, where it will be reduced to 10 inches. The turret armor is to be 17 inches thick in front and 15 inches elsewhere. From barbette to barbette the sides of the vessels from the armor belt to the main deck will be protected by plates not less than 5½ inches thick. Coal is to be carried back of a portion of this casemate armor. There will be a protective deck to extend throughout the length of the ships. Where worked flat the deck will be not less than 2¾ inches, and where its sides are inclined the slopes will be 3 inches thick forward and 5 inches thick aft. A cellulose belt is to be fitted along the sides of the whole length of the vessels. A conning tower is to be fitted, 10 inches in thickness, having an armored communication tube not less than 7 inches thick, affording protection to the voice-tubes, bell-wires, etc. A second armored station will be located aft. It will be constructed of plates 6 inches thick. In the wake of the 6-inch guns on the main deck there is to be continuous armor 5½ inches thick extending between the turrets. Further protection is to be afforded by 1½-inch splinter bulkheads between the guns extending from deck to deck. The 6-inch guns on the upper deck will also be protected by 5½ inches of armor and 1½-inch splinter bulkheads between guns. Protection will be afforded the smaller guns by sheaths and extra side plating. The vessels will be driven by twin screws. The engines are to be of the vertical triple-expansion type, two in number, in two separate compartments. The boilers are to be of the cylindrical single-ended pattern, eight in number, placed in four compartments. The electric lighting plant is to consist of three units, each unit having engine, dynamo and combination bed-plate, and each dynamo having a rated output of 400 amperes at 80 volts.

The Department will have a number of torpedo-boats at its disposal this fall. The official statement gives the date of completion of five of these vessels in November next. Another will be completed by next February. The submarine torpedo-boat is being rapidly advanced toward completion, and is slated to be ready for her official trial by January of 1897.

The Holland Submarine Torpedo Boat.

[Scientific American.]

Mr. J. P. Holland, an adopted citizen of the United States and a native of Ireland, for nearly twenty years has been working on this subject—

submarine navigation—and has built three boats, the first of which was begun in 1877. Ten years later he proved his plan to be so far practical as to be able to interest the naval department, which issued a circular to inventors calling for designs. Meanwhile in foreign countries other submarine boats were being tried, none of them seeming to prove entirely successful, or at least not succeeding in winning the desired confidence of the naval authorities. But at last, in the present boat, we have a *bona fide* war vessel being built under contract for the United States Government, and one which it is hard to believe will not be a valuable auxiliary to the Navy.

The Holland vessel is of cigar shape, with frames 3½x3½ inches, weighing 12 pounds to the foot. Her outside plating is ½ inch thick, tapering to ⅜ inch at the extreme ends of the vessel; for a portion of her length she is double skinned. She is propelled by triple-expansion engines actuating triple screws as long as the smoke-stack is above the surface; and for her diving operations, when the smoke-stack has to be completely housed, the residual pressure of the steam will be used for her propulsion, water heated under pressure evolving steam for a long time. Then, when this fails, she will have her storage batteries and electric motors to operate the propellers.

Three stages of flotation are provided for; in her light condition with the hull well above the water she is to make 13½ knots per hour; her next stage is that termed the "awash" condition. For this the body of hull is submerged, an armored superstructure, including a conning tower with 8-inch Harveyized steel plates, projecting above the surface, while concentrically placed, the air-tube and the smoke-stack rise above the whole. The superstructure is carried forward and aft, and pointed at both ends to give a clean entrance and run, so as to interfere as little as possible with the speed. Her speed under these conditions is to be 12½ knots an hour. Her third stage is the submerged condition. For this the smoke-stack and air-tube are housed, the opening through which they projected is hermetically closed, and the vessel is in condition to be sunk to a depth not exceeding 45 feet, her strength of construction being sufficient to enable her to resist the pressure of the water at this depth. She still has flotation, there being a margin of 375 pounds of buoyancy in her favor, the submersion being obtained by special devices. Submerged she is to make 6½ knots per hour.

The submersion is to be effected in two ways. At her stern she carries horizontal rudders. If the vessel is moving, by inclining these rudders the bow is caused to pitch downward and the vessel runs down an inclined plane determined by her axis, the inclined plane really representing the resultant of her buoyancy as a vertical upward component and her inclination of axis as a downward acting component. This diving action is similar to that used in the old Tuck submarine boat Peacemaker, which has been several times described in our columns. But the vessel is also to be able to dive from a state of rest. To secure this power she carries at her bow and stern two screws with vertical axes actuated by electric motors. By working these screws in one or the other direction, at varying rapidity, the vessel can be sunk rapidly, can be maintained at any desired level, can be rapidly drawn upward to the surface, or its approach to the surface can be made as slow as desired.

It having at last been settled that ocular navigation is impracticable under water, a tube is provided to be raised above the surface when the

vessel is submerged, which tube is to carry an inclined mirror or prism, camera lucida fashion, by which the commander will be able to watch the enemy and guide his course. In the restricted volume of the boat a compass cannot be used, owing to the proximity of so much iron and steel. An attempt is to be made to hold her mechanically in a straight course by a triangular drag. The theory of this is that she should be started on a proper course by ocular methods, with the drag set astern of her when on such course, any inclination from the desired direction causing the drag to pull to one side or the other, actuating the rudder so as to bring her back to her original course.

She is to carry five automobile torpedoes, two expulsion tubes and the necessary air plant for operating them. When diving, she must be able to reach a depth of 20 feet below the surface of the water within one minute from the light condition; when awash, she must be able to dive to the same depth within 30 seconds. She has an automatic pressure diaphragm which governs her submersion so that she cannot exceed the safe depth.

The air supply is primarily obtained from reservoirs, where it is stored under 2000 lbs. pressure. Moreover, a float with air-tube is provided which can be allowed to ascend to the surface, when air can be pumped down through the tube into the hull.

The following are the dimensions: Length, 80 feet; diameter, 11 feet; displacement, light, 118.5 tons; displacement, awash, 137.84 tons; displacement, submerged, 138.5 tons; reserve buoyancy submerged by motion or awash, 0.66 tons; reserve buoyancy submerged lying still, 375 pounds; horse-power of engines, 1800.

Provision is to be made for the escape of the crew in case of accident. This will take the shape of buoyant diving helmets or suits, and a method of opening the hatch so as to escape if the boat remains submerged.

[ENGLAND.]

THE MARS.

[ENGINEERING.]

The battle-ship Mars, which was floated out of Messrs. Laird's dock on Tuesday, March 31, belongs to the same class as the Majestic and Magnificent, which have been fully described already in Engineering, but the leading dimensions may be repeated: Length, 390 ft.; breadth, 75 ft.; mean draught, 27 ft. 6 in.; displacement, 14,900 tons; freeboard forward, 25 ft., aft, 18 ft. 6 in.; power of engines with forced draught, 12,000 indicated horse-power, with natural draught, 10,000; speed, natural draught, 16½ knots, forced draught, 17½ knots; coal carried at the designed load draught, 900 tons, with a reserve of 500 tons a side, making a total stowage for 1900 tons, with which she will steam at 10 knots for about a month, or 8000 knots. The reserve bunkers form additional protection with an armored deck behind side armor. The barbette guns are above the water-line 27 ft. The citadel or side armor is 220 ft., with a vertical height of 15 ft., and is of Harveyed steel, 9 in. thick. The barbettes have armor 14 in. thick. The protective deck, from lower edge of armor, covering machinery, magazines, and other vital parts, has 4 in. on slopes to 2½ in. on the flat, and extends to the extreme ends. The port and starboard engines and boilers are separated by a middle-line bulkhead. The main

propelling machinery consists of two sets of engines of the triple-expansion inverted type of Messrs. Laird Brothers' design. The screw propellers are four-bladed, the blades and bosses being of manganese bronze. The boilers are eight in number, single-ended, of the cylindrical return-tube type. Each pair of boilers is in a separate water-tight compartment, with independent coal supply, separate access to and from main deck, etc. There are two distillers with circulating and distributing pumps, four Admiralty type main feed and four auxiliary feed pumps, of ample size to supply the whole of the boilers at full power, and four double cylinder double-acting bilge and fire pumps, and a pump for pumping out the drain tank. The several pumps are connected to the large drain pipe and double bottom. General ventilation is secured by two large fans 72 in. in diameter, and eight fans 72 in. in diameter supply the forced draught for the boilers. The Mars illustrates the advantage of building these large battle-ships in dock in preference to building them on a slip and launching them, as she carries with her all her citadel armor, most of the barbette armor, and four casemate fronts; indeed, all the armor-plating would have been completed had it not been for the press of work in Sheffield rendering it impossible for the armor-plate manufacturers to make delivery as early as required. The main boilers are on board, with all mountings and connections complete, ready for steam, save the funnels. The whole of the auxiliary machinery is also in place, and pipes and connections fitted, and the main engines are fully two-thirds erected on board, so that the vessel, as floated out from the building dock, is in a far more advanced state than would have been the case had she been launched in the ordinary way. The order for the Mars was given exactly two years ago on March 26, and the steel and other materials were obtained and her keel laid on June 2, 1894, practically 22 months to date. When ready for the pennant in six or eight months, she will have a complement of 750 men.

The Ranger.

The Ranger is the third and last of three torpedo-boat destroyers which Messrs. R. and W. Hawthorn, Leslie and Co., of Newcastle-on-Tyne, have built for the Admiralty. On April 1 she made her official full-speed trial off the mouth of the Thames, the particulars of which are of interest. The vessel, like her sisters the Sunfish and the Opossum, is 200 ft. long and 19 ft. wide. The draught on trial was 5 ft. forward and 8 ft. 1½ in. aft, at which the displacement was 278 tons. These figures refer to the commencement of the trial. Naturally as coal was burnt the displacement and draught decreased. The trial was for the usual three hours, six runs being made on the Maplin measured mile, the mean speed for the whole distance being 27.172 knots. The Ranger has three-stage compound engines, having cylinders 18½ in., 28 in., and 42 in. in diameter, the stroke being 18 in. The cooling surface in the condensers is 3000 square feet. The boilers are of the Yarrow type, and are eight in number. Each has a grate area of 21 square feet, and a heating surface of 1063 square feet. On the trial the average steam pressure in the boilers was 194 lbs. to the square inch, the air pressure in the stokeholds 3.07 in., and the vacuum 24.2 in. The revolutions averaged 348.25 per minute. The aggregate horse-power for both sets of engines was 4055 indicated. During the six runs on the mile the speed was 27.093 knots, which, it will be seen, was less than that for the whole distance. This is a cir-

cumstance that has before occurred on the trials of destroyers having water-tube boilers, but which we do not remember ever to have observed in the case of flame-tube boilers. It may doubtless be taken as a testimony to the superior endurance of the former class of steam generator, or perhaps one should say to the greater ease with which the best designs of water-tube boilers are fired, and, therefore, to the superior endurance of the stokers. As is well known, the "human factor" is almost as of great importance as the "machine factor" in the trials of these small quick-running craft.

The Haughty.

The torpedo-boat destroyer Haughty, which was built by Messrs. William Doxford & Sons, Limited, of Sunderland, and fitted with eight of Yarrow's water-tube boilers, on her official trials made 27.949 knots as the mean on the six measured-mile runs, the engine revolutions being 371.74. The speed registered on the three hours' trial was 27.525 knots. The revolutions were 362.3, with an indicated horse-power of 4224, steam pressure in the boilers 188 lbs.

Mr. Beauchamp Towers' ingenious apparatus for providing a steady platform at sea has been fitted by Sir W. G. Armstrong & Co. to the torpedo-boat destroyers Swordfish and Spitfire, and is also to be supplied to a Chilian cruiser now building at Elswick. The apparatus, it will be remembered, depends on the fact that a gyroscope tends to maintain an invariable plane of rotation. In practice, a gyroscope is arranged to rotate about a vertical axis. As the vessel rolls, the gyroscope, maintaining its original plane of rotation, tilts relatively to the vessel, and this relative motion is used to control the supply of water to a set of four hydraulic cylinders connected to the steady platform in a suitable manner. In practice it is found that with it a search-light on a small vessel can be kept quite steady on a mark even in a heavy sea.

The Renown.

The first-class battle-ship Renown, which has been built at Pembroke, made her full-speed contractors' steam trial in the Channel on April 6. The eight hours' natural draught trial was run on the 27th of March.

The Renown is a particularly interesting ship at the present time, as she is to be the prototype of the five new battle-ships which are in this year's naval programme. The vessel is 380 ft. long and 72 ft. wide, and is designed to have a displacement at load draught of 12,350 tons. The engines are of the three-stage compound type, having cylinders 40 in., 59 in., and 88 in. in diameter by 4 ft. 3 in. stroke. The high-pressure engine has a piston valve, the ordinary flat valve being used for the intermediate and low-pressure engines. The propellers are of gun-metal, and are 16 ft. 6 in. in diameter and 21 ft. mean pitch. There are eight single-ended return-tube boilers, each 16 ft. 6 in. in diameter and 10 ft. 3 in. long. They have each four furnaces. The total grate area is 793 square feet, and the total heating surface 24,840 square feet.

For the eight hours' natural-draught trial a very early start had naturally to be made. The conditions were fairly favorable to the ship, the wind being of a strength from 3 to 4 and the sea moderate. The trial ground selected was from the Start to the Lizard, the ship running up and down

the coast far enough out to be in deep water. The mean results were: Steam, 143 lbs.; vacuum, starboard 26.9 in., port 26.9 in.; revolutions, starboard 97.5, port 98.2; indicated horse-power, starboard 5233, port 5475 —total, 10,708; speed, 17.9 knots. Messrs. Maudslay, Sons & Field, the makers of the machinery, were responsible for an indicated horse-power of 10,000 only on the natural-draught trial, but more than once during steaming the engines easily attained 11,000 indicated horse-power, while the mean was 708 in excess of the stipulated power. The mean speed was exactly 1 knot more than her designers anticipated that the vessel could attain on her natural-draught trial, and $\frac{7}{10}$ knot more than it was estimated she would steam under forced draught with 12,000 indicated horse-power.

We now turn to the full-power trial of April 6. The ship had been taken into the Hamoaze after her natural draught trial, and in steaming out of the very crooked channel leading into Plymouth Sound gave unmistakable evidence of her handiness, both engines being kept going steadily ahead, the vessel swinging to her helm with remarkable promptitude. Such a performance was highly gratifying to those who remember the somewhat erratic performance of certain armor-clad ships of past times. The ship having passed out of the Sound into the Channel, hatches were soon closed and the trial commenced at 12.12 P. M., the course being first to the westward. The day was all that could have been desired for a trial, the wind being no more than a gentle breeze and the sea quite smooth. The engines were opened out full, there being no difficulty in keeping steam, in fact, the safety valves were lifting part of the time.

As will be seen, the air pressure was quite moderate, averaging about $\frac{7}{10}$ in., and though the engines developed 901 units above the contract horse-power, the engineers are confident that considerably more power could be obtained were the slides altered and the full air pressure allowed by the Admiralty regulations taken advantage of. How far this would result in additional speed is, of course, an open question, but the ship seemed to pass through the water so easily at the highest rate of steaming that possibly a good deal more might be got out of her if considered desirable.

The following are the mean results of the half-hourly observations on the full-speed trial: Steam pressure in engine-rooms, 145 lbs.; vacuum, 27.3 in.; air pressure in starboard boiler-rooms, .6 in.; in port boiler-rooms, .8 in. Revolutions of starboard engines, 101.6 per minute; of port engines, 106.5 per minute. Mean pressures per square inch of piston: Starboard engines: High-pressure cylinder, 67 lbs.; intermediate cylinder, 27.8 lbs.; low-pressure cylinder, 13.5 lbs. Port engines: High-pressure, 63.6 lbs.; intermediate cylinder, 28.7 lbs.; low-pressure cylinder, 13.4 lbs. Indicated horse-power, starboard engines, high-pressure, 2206; intermediate cylinder, 1993; low-pressure, 2141—total, starboard, 6340. Port engines—total, port, 6561. Total indicated horse-power, 12,901, or 901 in excess of the contract. The engines worked well and steadily throughout the trial. The speed, as taken by cross bearings from points on the coast, was 18.75 knots for the whole distance steamed, the vessel making several turns and running up and down so as to equalize the influence of the tide.

A subsequent thirty hours' consumption trial shows that her most economical rate of steaming is three-fifths of her full natural draught engine power, at which she made a speed of over 15 knots, the vessel being ballasted to give her the same draught, 26 ft. 9 in., as she will have

when in commission fully completed for sea service. The mean results of the trial were: Steam, 137 lbs.; vacuum, starboard, 27.8 in.; port, 26.8 in.; revolutions, starboard, 85; port, 88.6; indicated horse-power, starboard, 3143; port, 3044; total, 6187; air pressure, nil; speed, 15.3 knots. The coal consumption was 1.88 lb. of coal for each indicated horse-power per hour; the coal stowage capacity at load draught is 800 tons.

The Desperate.

The official trial of the torpedo-boat destroyer Desperate was successfully made on April 16. Hitherto contractors have been allowed unlimited coal and horse-power, no restrictions being placed upon them, so long as they attained the required speed with the specified weight on board. In the case of the 30-knot vessels, not only was an additional speed of 3 knots over that of the former number demanded, but it was also laid down that the coal consumption on the full-power trial should not exceed 2½ lbs. per indicated horse-power per hour, if the minimum load of 35 tons were carried, the load penalty being 2 tons additional for every tenth of a pound that the coal consumption exceeded the 2½ lbs. It is well known that the very high speed of these little vessels has hitherto been largely due to a total neglect of the economy question when running at the highest speeds, although the boats were fairly economical at lower powers. The practice was perfectly defensible, because the boat would not be expected to run at her highest speed, either in war or peace times, but for short periods, and then a few pounds of coal would not be of great importance unless the circumstances were altogether exceptional. Experience shows, however, that the conditions were not impossible. The trial was run on the Maplin mile in rough weather. A weighed quantity of coal, estimated to be sufficient to take the boat down river to the trial ground, was placed in bags, whilst in the bunkers there was a quantity of coal estimated to be sufficient for the three hours' trial. On the vessel reaching the mile, and the trial commencing, there remained over a ton of coal still in the bags, and this was of course put by, so as to be beyond the reach of the stokers. At the termination of the three hours a considerable quantity of coal remained. The bunkers were sealed up by the Admiralty officials, and immediately on the return of the boat the quantity was ascertained. The result of the trial was that the indicated horse-power was 5620, and the coal consumption 2.491 lbs. per indicated horse-power per hour. The speed on the whole run was 30.112 knots. The full load of 35 tons was of course carried. The steam pressure averaged 209 lbs., the vacuum 24 in., and the revolutions 398 per minute. The air pressure for draught averaged 3½ in. on the water gauge, and the coal burnt was about 80 lbs. per square foot of grate per hour. As our readers are aware, the Desperate has made previous trials, and on one occasion, with a reduced load, she made on the mile a speed of just over 31 knots, whilst on another occasion she steamed 30.46 knots with full load. On both these trials, which were of a preliminary nature, the coal consumption was above the standard. Messrs. Thornycroft have since fitted an arrangement by means of which air at 10 lbs. to the square inch pressure is introduced at the front about 2 ft. above the fire, there being 9 or 10 jets to each furnace. This was found on the trial to give very good results, the quantity of smoke being much reduced, and the flame, which so often results from the escape of unburnt gases, being entirely absent

from the chimney tops. The latter feature in itself is one of great importance in torpedo vessels. It will be seen from what has been said that Messrs. Thornycroft have scored still another success with their most recent boat. Certainly to drive a boat 210 ft. long at a speed of 30 knots on so light a consumption as that stated is a remarkable thing, even in these days of phenomenal speeds. The low fuel consumption bears out the consumption trials made by Professor Kennedy some time ago, when the water evaporated by the Thornycroft boiler was measured. The Admiralty have this week placed with this firm a further order for three more 30-knot destroyers and one of 32 knots. The latter will be a larger vessel than the Desperate class, and will of course have more power; there will be four boilers in place of three. The other three boats will doubtless be sister ships of the Desperate now that that vessel has done so well on trial.

The Hannibal.

The battle-ship Hannibal was launched from the Pembroke dockyard on April 28. She belongs to the same class as the Majestic and Magnificent. Her keel was laid on May 1, 1894. The machinery, of 12,000 indicated horse-power, to give a speed of 17½ knots, is being supplied by Messrs. Harland & Wolff, Belfast.

The Hunter.

The torpedo-boat destroyer Hunter, built by the Fairfield Shipbuilding Company, had a three hours' trial of her machinery at Portsmouth on May 17. Her draught was 5 ft. 1 in. forward and 7 ft. 5 in. aft. The steam in boilers was 195 lbs., with a total indicated horse-power of 4245. She gave a mean speed of 27.245 knots during six runs on the measured mile. The trial was regarded as highly satisfactory.

The Arrogant.

The Arrogant, fleet cruiser, was launched from Devonport Dockyard on May 26. She is the first of four of the same type now under construction from the designs of Sir W. H. White, Director of Naval Construction, the others being the Gladiator, building at Portsmouth; the Vindictive, at Chatham; and the Furious, at Devonport. In size they are a medium between the second-class cruisers of the Astræa class and those of the Talbot type, and in several respects they differ from any cruisers yet built. The principal dimensions of the Arrogant are: Length, 320 ft.; breadth, 57 ft. 6 in.; mean load draught, 21 ft.; displacement, 5800 tons. Rapid progress has been made with the construction of the Arrogant. Her keel was laid on June 10, 1895, and she was pushed forward so expeditiously that she might have been launched two months ago had her underwater fittings been ready. The engines are of the twin-screw, triple-compound, vertical inverted cylinder type, and are guaranteed to develop 10,000 indicated horse-power. They are placed abreast of each other, in separate engine-rooms, divided by a fore-and-aft water-tight bulkhead. The high-pressure cylinder has a diameter of 26 in., the intermediate of 42 in., and the low of 68 in., while the stroke is 39 in. Other dimensions of interest are: Connecting-rod centers, 6 ft. 6 in.; piston-rod diameter, 7¼ in.; crankshaft diameter, 13¾ in. external and 7¾ in. in-

ternal; air pump, 27½ in. in diameter and 11 in. stroke. Condensers of the cylindrical type, with a cooling surface of 5280 ft. in each, are placed in the wings of the engine-rooms. In all there are over 50 auxiliary engines, besides Normandy's distillers and Weir's evaporators. There are 18 water-tube boilers of the Belleville type. They are arranged in groups of six in three independent boiler-rooms, divided by athwartship water-tight bulkheads. The boilers have a grate area of 860 square feet, and a heating surface of 22,050 square feet. The steam pressure of the boilers is 300 lbs. per square inch, and by means of reducing valves placed in the main steam pipes it is reduced to 250 lbs. per square inch at the engines. The engines and boilers are being manufactured by Messrs. Earle's Shipbuilding and Engineering Company, Hull. The armament will be throughout of the quick-firing principle, and will consist of four 6-in., six 4.7-in., eight 12-pounder (12 cwt.), one 12-pounder (8 cwt.), and three 3-pounder guns. There will also be five Maxim machine guns and two 18-in. submerged torpedo-tubes. From a fighting top on the vessel's mast a 3-pounder Hotchkiss quick-firing gun will be worked. The Arrogant is to be completed for sea by March, 1897. It is expected that on an eight hours' full-power trial she will attain a mean speed of 18.5 knots. She will be fitted with bunkers capable of stowing 500 tons of coal.

The Sharpshooter.

During the last few months the Sharpshooter, gunboat, has been the means of affording instruction in the use of Belleville water-tube boilers to five distinct classes from the Portsmouth Reserve. Each class consists of 25 stokers, two leading stokers, two chief stokers, and two engine-room artificers. It was at first intended that the ratings sent to the Sharpshooter for instruction should be held in reserve for eventual appropriation to the cruisers Powerful and Terrible, both of which are being furnished with Belleville boilers. In consequence, however, of the frequent demands recently made on the drafting dépôt at Portsmouth, several of the men who had the special course of instruction in the Sharpshooter have been sent on foreign service, and, in fact, to vessels fitted with the ordinary cylindrical boilers. Up to the present the total number of stokers passed through the Sharpshooter is 125, of whom considerably less than 100 are now in the Portsmouth Reserve. The cruisers Powerful and Terrible are each to have a complement including 200 stokers, so that the Sharpshooter is likely to be employed on her present instructional service for many months if the Admiralty's original intention to supply experienced stokers only to the new cruisers is adhered to. Each class sent to the Sharpshooter is temporarily appointed to her for one month.

Auxiliary Cruisers.

[Marine Rundschau.]

The English Government expends over fifty thousand pounds sterling in subsidies for the following steamers: Campania and Lucania, of Cunard Line; Teutonic and Majestic, of White Star Line; Himalaya, Australia, Victoria, Arcadia, of P. and O. Company; Empress of India, Empress of China, and Empress of Japan, of Canadian Pacific Line. Besides the foregoing vessels, the steamship companies place the following ships at

the disposal of the Admiralty without subsidies: White Star steamers Britannic, Germanic, Adriatic; Cunarders Etruria, Umbria, Aurania, Servia; P. and O., Britannia, Oceana, Peninsular, Oriental, Valetta, Massilia, Roma, Carthago, Ballaarat, Parramatta.

[FRANCE.]

THE BOUVET.

[JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.]

On the 27th of April, at Lorient, the new first-class battle-ship Bouvet was successfully launched. She is the largest battle-ship as yet constructed or building for the French navy, and her dimensions are as follows: Length, 401 feet 2 inches; beam, 70 feet 3 inches; and with a maximum draught of 27 feet 6 inches she has a displacement of 12,205 tons. The engines are to develop 14,000 I. H. P., giving a speed under forced draught of 17.5 knots; there are three sets of engines driving three screws, and the boilers will be of the Belleville water-tube type. Protection is afforded by a water-line belt 16 inches thick amidships, and tapering to 8 inches at the bow and stern; there are two armored decks, the upper one being 3.8 inches thick; the barbettes for the heavy guns will be protected by 14.5-inch armor, and the turrets for the 6-inch Q. F. guns by 4 inches; all the armor will be of special steel, treated with nickel and manganese. The heavy armament will consist of two 30-cm. (12-inch) guns in closed turrets, one forward and one aft; of two 27-cm. (10-inch) guns also in turrets, one on each beam; these guns are of the latest (1893) model, and the breech mechanism can be worked by hand. The ammunition hoists discharge alongside the gun, and the projectiles are conveyed by means of an overhead rail, either directly to the loading position or to the rack made to contain eleven projectiles. The loading is done by hand, while the turrets are trained by hydraulic power, which is also used for the elevation of the guns. The secondary battery consists of eight 14-cm. (5.5-inch) Q. F. guns (model 1891) and eight 10-cm. (3.9-inch) Q. F. guns, also of the 1891 model. The eight 14-cm. guns are in armored turrets in couples, four firing right ahead and four astern, these turrets being in close juxtaposition to those of the heavy guns. The elevation is by hand, while the turrets can be worked either by hand or hydraulic power, as also can the ammunition hoists. The eight 10-cm. guns are on the superstructure on central pivot mountings, with 2-inch shields for protective purposes. There are, further, twelve 3-pounder Q. F. guns and twenty 1-pounder Q. F. guns distributed on the bridges and in the tops, with four torpedo-dischargers, two of which are under water.

THE GALILÉE.

The Galilée, French third-class cruiser of the Linois type, was launched at Rochefort on the 28th of April. With her sister, the Lavoisier, she has been designed by M. Albaret, and her total cost will be £208,000. The following are her dimensions: Length, 330 ft.; beam, 34 ft. 6 in.; stern draught, 17 ft. 10 in.; displacement, 6400 metric tons. She is to carry four quick-firers of 5.5 in. (model 1887) in sponsons two on a side, two of 3.9 in. model (1891), severally fore and aft, eight of 1.8 in., and eight of 1.4 in. There are two above-water torpedo-tubes. The six heavier guns

will have 2-in. steel shields, and the ship has a protective deck 1.5 in. thick. The engines are of the vertical triple-expansion type, supplied by Belleville boilers, working up to 4000 horse-power normal and 6600 with forced draught, and the nominal corresponding speeds are 18 and 20 knots, but it is hoped the latter will be exceeded. The bunker capacity is 226 tons, giving a range of 3000 miles at 10 knots and 600 miles at full speed. The complement of the cruiser will be 11 officers and 287 men.

The D'Assas and the Cassard.

These two second-class protected cruisers, sisters to the Duchayla, have been successfully launched, the D'Assas at Saint Lazaire, and the Cassard at Cherbourg. These three vessels were designed by M. Lhomme. Dimensions: Displacement, 3592 metric tons; length, 325 ft. 6 in.; beam, 44 ft. 10 in.; extreme draught, 20 ft. 5 in. The protection consists of a steel deck, having a maximum thickness of 2.3 in., and hardened steel shields to the guns. These are six 6.4-in., four 3.9-in., ten 1.8-in., and eleven 1.4-in. quick-firers, with two above-water torpedo-tubes. Two sets of vertical triple-expansion engines, supplied by D'Allest boilers, are to develop 9500 indicated horse-power, giving a speed of 19.25 knots. The coal capacity is 614 tons, sufficing for 6000 miles at 10 knots, and for 1000 miles at full speed. Complement will be 22 officers and 371 men.

Submarine Boats.

The Minister of Marine has taken up seriously the question of submarine boats, and has offered a series of prizes for the best design for such a vessel. The displacement is not to exceed 200 tons, the surface speed is to be 12 knots, and the vessel must be able to go 100 miles at a speed of 8 knots, and also to maintain a speed of 8 knots under water for 10 miles. Two torpedoes ready for launching must also be carried. The designs will become the property of the Government. Full details and complete plans are to be sent in, which must also show the basis on which stability, form of the vessel, motive power, etc., have been calculated. The first prize will be 10,000 francs.

Accidents on board the Duperré and Jauréguiberry.

[Engineer.]

An alarming explosion occurred on May 14th on board the French ironclad Admiral Duperré. A loud report was heard and the after part of the vessel was soon filled with thick smoke, which was found to be issuing from the central powder magazine on the lower deck. The door of the magazine was hurled a distance of 30 ft., and investigation showed that a cartridge about 13 in. long had exploded, but that none of the other cartridges among which it was packed were discharged. The magazine contained 3000 kilogrammes of gunpowder and mélinite shells, none of which were disturbed in any way. The explosion is attributed to the overheating of the magazine by pipes from the boilers.

[Engineering.]

The ironclad Jauréguiberry, perhaps the finest boat in the French navy, went for her 24 hours' trial off Toulon on June 9. Up to the 20th hour

the trip proved most successful, a speed of over 17 knots being maintained without difficulty, and the 24 water-tube boilers, which are of the Lagrafel-d'Allest type, gave absolutely no indication of anything wrong. The fires had just been cleaned when a sound of explosion was heard in boiler No. 1. This was quickly followed by a rush of steam and flame from the furnace fronts, the doors being forced open, and before they could escape, nine stokers were so severely scalded that six died within a few hours of the accident. As soon as possible the injured boiler was isolated from its fellows by the courageous action of a foreman from the Forges et Chantiers de la Mediterranée, and later on it was examined with a view to discovering the nature of the accident. The Lagrafel-d'Allest boiler may, in principle, be described as a gigantic locomotive fire-box, in which inclined water-tubes cross the furnace from one side to the other above the grate. The water spaces between the internal and external fire-boxes are connected by means of these tubes, round which the flame passes on its way to the chimney. All the tubes are straight. After the accident it was found that one of these tubes had burst and drawn from the front tube-plate. A rush of water and steam took place from the opening thus formed, but probably if the damage had stopped here no very serious consequences might have resulted, but in addition it was found that no less than forty of the top tubes were bent, drawn from the tube-plate, thus affording a large means of exit to the scalding steam. Why these tubes should have yielded thus is not very apparent, unless the water-level had been allowed to get low. We may mention that a somewhat similar accident took place on the 20th ult. at Brest Harbor, when a boiler tube on one of the Niclausse boilers of the Friant gave way, scalding three stokers more or less severely.

[ITALY.]

THE CARLO ALBERTO.

[JOURNAL UNITED SERVICE INSTITUTION.]

The new first-class armored cruiser Carlo Alberto was launched at Spezia. She is a sister ship of the Vettor Pisani, which is in hand at Castellamare, and her dimensions are as follows: Length, 325 feet; beam, 59 feet, and with a displacement of 6500 tons, she has a mean draught of 22 feet 11 inches. She has an end-to-end belt of nickel steel from the Terni works, 6 inches thick, and a battery above protected with plating of the same thickness, extending more than a third of the ship's length. The battery is closed in with 2-inch steel athwartship bulkheads, and is provided with steel splinter-screens between the guns, and there is an over-all armored deck 1.4 inches thick. The ship has a double bottom, cofferdams filled with cellulose, and numerous water-tight compartments. The armament consists of twelve 5.9-inch Q. F. guns, of which eight are in the battery (four on a side) and four on the superstructure above at the corners of the armored casemate. On the superstructure also are six 4.7-inch Q. F. guns, two on each broadside, one forward and the other aft; and the smaller guns are ten of 2.2-inch and eight of 1.4-inch, of which several are for the tops of the two fighting-masts. The torpedo equipment consists of four broadside tubes and one in the bows. The machinery has been built by Messrs. Ansaldo. Two triple-expansion engines, developing together 13,000 H. P. with forced draught, are sup-

plied by eight boilers distributed in four compartments, and are to give a speed of 20 knots. The maximum coal supply will be 1000 tons, in addition to liquid fuel, and the complement of the ship will be 460 men.

It is proposed to lay down a 28-knot torpedo-boat destroyer of the Daring type, and two 24-knot sea-going torpedo-boats, two torpedo cruisers of the improved Caprera type of 1300 tons displacement and 23 knots speed, and an armored cruiser of between 8000 and 10,000 tons, with a speed of not less than 22 knots. These vessels will be built at Castellamare, where it is also proposed to lengthen the building slips 3 and 4. It is, however, doubtful how soon a beginning will be made with these ships, as it is now stated that the two new torpedo cruisers Principe di Napoli and Regina Margherita, the construction of which was sanctioned in the last budget, have not as yet been commenced, the money voted for them having been devoted instead to the campaign in Abyssinia. Progress, however, is to be made with the Agordat and Coatit, torpedo cruisers of 1313 tons, and which are to have a speed of 23 knots.

It is stated that Italy has four submarine boats now completed, and another on the stocks. France, however, claims to have made the furthest advances in this line, though even here the success has not been great, the highest speed yet recorded being only six to eight knots. Another great difficulty is that of seeing under water. Thus M. de Lanessan states that when he was some 20 feet under water on board the Goubel in Cherbourg Harbor, though he could see to read quite clearly, he could not distinguish the hulls of two vessels only some 10 feet to 12 feet away from him.

[RUSSIA.]

[UNITED SERVICE GAZETTE.]

On May 12th, in the presence of the Czar, two new war-ships, the Russia and the General-Admiral Apraxin, were successfully launched on the Neva. The cruiser Russia is the longest vessel ever launched on the Neva, and the largest Russian ship of the kind afloat. As a matter of fact, she ranks first only after the Powerful and Terrible, which are about 14,200 tons. The Russia is more or less a copy of the Rurik, but larger and more powerful. The Rurik is 426 feet long, with 10,933 tons displacement. The Russia is 464 feet between perpendiculars, with a displacement of 12,195 tons. Including the ram, the full length of the Russia is over 480 feet, and the greatest breadth over all is 68 feet. The Russia's coal-carrying capacity is 2500 tons. Her triple-expansion engines, made at the Baltic works, are 17,000 indicated horse-power, and her expected speed is 19 knots. The boilers, thirty in number, are of the Belleville type, made in France. The armor plates of the belt are made at the Carnegie mills in America. The cruiser has a double bottom and 149 water-tight compartments, and carries fourteen different boats, including steam launches. Her armament will consist of 8-inch, 6-inch, 75-millimeter, 47-millimeter, and 37-millimeter guns, besides torpedo apparatus.

The Russia, however, is to be followed by a still larger cruiser of similar type. It is intended to lay down one of 14,000 tons, which is to be the largest and most powerful cruiser in the world. The Rurik was answered in England by the building of the Terrible. The Russian rejoinder is the construction of the Russia and the larger one now pro-

jected, besides the two first-class ironclads laid down last year. The following are the particulars of the other ship launched on the same day, the Apraxin: Displacement, 4126 tons; length, 278 feet; beam, 52 feet; two triple-expansion engines, 5000 indicated horse-power. She will be armored for 177 feet of her length with plates 10 inches thick in the center of the vessel, gradually lessening in thickness towards the stem and stern. She will carry four 9-inch guns in revolving turrets, and twenty-two various rapid-firing guns, besides torpedoes, for which there are four dischargers.

A high record for ballistic efficiency was made by Carnegie armor plate at the Indian Head Proving Ground on Wednesday last. An 8-inch plate, representing 600 tons of armor for the cruiser Russia, under construction for the Russian government, was tested with remarkably good results. The group was accepted on the showing made, and in addition Capt. Mertwago recommended to his government that the group of armor yet to be manufactured be accepted without ballistic trial. This latter group comprises 200 tons. Some weeks ago, as we announced at the time, there was a test of a 5-inch plate, representing a group of 350 tons of armor, for the cruiser Russia, and this group was accepted. If the Russian government adopts Capt. Mertwago's recommendation that the remaining group of 200 tons be accepted without test, the entire order of 1150 tons for the Russia will be delivered in a very few months more. Naval attachés of foreign countries in Washington and representatives of the press will hereafter be excluded from trials at the Indian Head Proving Ground.

Georgie Pobedonosetz.

The latest addition to Russia's Black Sea fleet has recently satisfactorily completed her steam and gun trials at Sevastopol. The Georgie Pobedonosetz is a first-class battle-ship of 10,280 tons displacement, 320 feet in length, 69 feet beam, and mean draught of 26 feet 7 inches, speed 16½ knots. The bunkers are capable of carrying 700 tons of coal. The armament consists of six 12-inch 56-ton breech-loading guns of the Russian Krupp pattern, carried in three barbettes, two barbettes being placed abreast on the forward deck of the ship, each barbette carrying two guns, the remaining two guns being situated in a barbette upon the after deck. There are also seven 6-inch 6-ton breech-loading guns, eight 10-centimeter quick-firing, and six machine guns. The vital portions of the vessel are protected by a belt of 16-inch, and the barbettes by 12-inch compound armor plates. The propelling machinery is of the vertical inverted triple-expansion type, having cylinders 45 inches, 66 inches, and 100 inches in diameter, and common stroke of 4 feet, driving twin screws of 16 feet 6 inches diameter. Working steam pressure, 150 lbs. per square inch. Steam is supplied by 16 boilers arranged in four separate compartments. They are of the cylindrical single-ended type, having three furnaces each, the total grate area being 980 square feet, and total heating surface 29,100 square feet. Air is supplied by means of 12 double-breasted fans, each of 5 feet diameter. Upon May 21, at 8.30 A. M., the vessel left Sevastopol Harbor for official steam trial, the stipulated power being 10,060 horses, to be maintained for six consecutive hours with assisted draught, ½ inch air pressure in the stokeholds being the maximum allowed. The mean result of six hours' trial was 13,468 indicated horse-power. The result is considered highly satisfactory, the above-mentioned horse-power (nearly 3000 in excess of the contract) being main-

tained with ease by the ordinary ship's crew of Russian stokers and artificers, led by a small staff of Englishmen. The ship returned to harbor in the evening. Upon the following day the vessel again put out to sea for artillery trials, the results of which were highly satisfactory, both guns and mountings being thoroughly tested during a trial which lasted nearly 12 hours. The Georgie Pobedonosetz will now join her sister vessels Sinope, Catherine II., Tchesma, and Dvenatdset Apostoloff, forming together a fleet of five first-class battle-ships complete and equipped ready for service. The last ironclad launched in the Black Sea, viz., Tri Svilitela, awaits steam trials, which, however, will probably not take place during the current year.

The Kherson.

[Journal Royal United Service Institution.]

On May 16th an official trial was made off the Tyne of the Russian volunteer fleet steamship Kherson, which has been built and engined by Messrs. R. & W. Hawthorn, Leslie & Co., of Newcastle-on-Tyne. This vessel, which is the thirteenth of the fleet, is arranged to carry an armament of seven 4.7 Q. F. guns and twenty others guns of smaller natures. These are kept in store at Odessa, to be shipped in case of war. She is a twin-screw vessel, 492 feet long and 54 feet 3 inches wide. The engines are of the triple-expansion type. The chief interest in the machinery department centers in the boilers. These are of the Belleville water-tube type, similar in construction to those which are being placed in the British cruisers Powerful and Terrible, now in course of completion. On a twelve hours' trial the Kherson made her contract speed of 19.5 knots, but the H. P. exceeded the estimate, the mean of the twelve hours being 13,150 I. H. P. The sea was rather rough, which detracted somewhat from the speed. The steam pressure of 250 lbs. was maintained with ease during the trial, although the stokers were quite unused to this type of boiler. The boilers were supplied by Messrs. Maudslay, Son & Field, of London.

[Germany.]

[Journal of the Royal United Service Institution.]

The necessary votes having been approved by the Reichstag, the Ministry of Marine has accepted the tender of the Vulcan Yard at Stettin for the construction of the second-class cruiser N; the ship is to be completed in two years and a half. A cruiser of a similar type was commenced in October last year at the same yard, which is to be completed in twenty-five months from the date of commencement. It has also been decided that the new first-class battle-ship Ersatz Friedrich der Grosse is to be laid down at Wilhelmshaven, and the second-class cruiser M at the imperial dockyard at Danzig. The fourth-class cruiser G is also to be built at a private yard, but the contract has not yet been given out. Altogether there are under construction or to be commenced in the Imperial dockyards the two first-class battle-ships Ersatz Preussen and Ersatz Friedrich der Grosse, the first-class armored-cruiser Ersatz Leipzig and the two second-class cruisers Ersatz Freya and M; while in private yards are already building or to be commenced three second-class cruisers K, L, and N, and the fourth-class cruiser G. According to present

arrangements, it is hoped that the launch of the first of these ships, one of the cruisers, will take place in the autumn. Each of the five new cruisers is to have three screws, the engines being in separate compartments; the I. H. P. to be developed is 10,000, giving a speed of 22 knots. The guns are to be in 4-inch armored casemates, and the armored deck will also be 4 inches thick.

Coaling Station.

The Ministry of Marine has determined to construct a large coaling station at the eastern entrance to the Kaiser-Wilhelm Canal, and the necessary works are to be commenced this summer; the coal depot is to be 566 feet long, with a depth of 68 feet, and will be placed on the south bank of the entrance to the canal and immediately adjoining the new torpedo-boat harbor; it will be connected by rails with a mole 890 feet long, the water alongside which will be of sufficient depth to allow the largest battle-ship to come alongside and take in her coal. Hydraulic cranes are to be provided. The whole work is to be completed in two years. A similar coaling station is to be constructed at the Bruisbuttel harbor, at the west entrance of the canal. At both depots 77,000 tons of coal are to be stored.

[Austria.]

The Buda Pest.

[Royal United Service Institution.]

On April 27 the new coast-defense battle-ship Buda-Pest was launched from the Stabilimento Tecnico Triestino at San Rocco, near Trieste. The principal dimensions of the ship are as follows: Length, 303 feet 6 inches; beam, 55 feet 3 inches; displacement, 5550 tons; mean draught, 20 feet 6 inches. The hull of the ship is constructed of Siemens-Martin steel, divided into the usual cellular and water-tight compartments, while the pumps will be sufficiently powerful to discharge 1500 tons of water hourly in case of necessity. Protection is afforded by an armor belt of 10.8-inch nickel steel, made by the Austrian firm of Witkowitz & Co., tapering to 8 inches aft and 5 inches forward, which runs from the ram for five-sixths the length of the ship, extending from 3 feet 6 inches below to 3 feet 6 inches above the water-line at normal draught, the after ends being joined by an 8-inch armored athwartships bulkhead. On the top of the belt runs fore and aft the whole length of the ship a 1.8-inch armored deck, rising above which, and extending from the after end of the armored belt for about two-thirds of the ship forward, is a citadel protected with 3.3-inch armor, with transverse bulkheads of the same thickness of plating. Above again, on the upper deck, is a smaller citadel, also protected with 3.3-inch armor, fore and abaft which, but with their basis protected by the armored lower citadel, are the two barbettes for the heavy guns, plated with 8-inch armor and fitted with 2.5-inch steel hoods for the guns. There are, further, two conning towers, the foremost with 8-inch plating, the after with 2.5-inch. The whole weight of the armor amounts to 1700 tons. The armament consists of four 24-centimeter (9.4-inch) 40-caliber long Krupp guns, mounted in pairs in the barbettes. Each gun weighs 26 tons, and the mountings for each pair of guns, including the hood, 123 tons. The armor-piercing projectile,

which weighs 474 lbs., has an initial velocity of 2275 feet, and, with an elevation of 22°, has a range of 16 kilometers (10 miles). The secondary battery consists of six 15-centimeter (5.8-inch) Q. F. guns, two 7-centimeter Uchatius guns for boat and landing purposes, sixteen 3-pounder Q. F. guns, and two mitrailleuses with broadside torpedo-tubes. The six 15-centimeter Q. F. guns are mounted in the citadel on the upper deck, two firing from right ahead to 70 abaft the beam and two from right aft to 70 before the beam; the other two are on the broadside. The guns are separated from each other by steel splinter-proof bulkheads. Ten of the 3-pounder Q. F. guns are mounted on the superstructure over the upper citadel. The guns, barbettes, and ammunition hoists are all to be worked by electricity, the ammunition for the heavy guns and secondary battery being provided through separate armored tubes. The engines are intended to develop 6000 I. H. P. under natural draught, giving a speed of 16 knots, and 8500 I. H. P. under forced draught, the corresponding speed being 17.5 knots. The coal capacity is 500 tons, giving a cruising radius of 3000 miles at 10 knots.

[SPAIN.]

THE VILLALOBOS.

[MARINE RUNDSCHAU.]

The Spanish gunboat Villalobos, sister ship of the Quiros, was launched at Hong Kong. The gunboat is destined for service in the Philippine Islands. She carries two R. F. guns and 2 machine guns. Displacement 315 tons, 300 I. H. P.

THE ALMIRANTE OQUENDO.

The cruiser Almirante Oquendo has had a successful trial trip at Bilboa. With natural draught and 105 revolutions, the engines developed 9000 I. H. P., giving a mean speed for six hours of 18.4 knots. With forced draught and 117 revolutions, 13,000 I. H. P. was developed, with an average speed of 20.3 knots. The Oquendo is the last of the three armored cruisers built at Bilbao; the two sister ships are the Infanta Maria Teresa and Vizcaya. The following are the dimensions: Length, 364 feet; beam, 65 feet; draught, 21 feet 6 inches; displacement, 7000 tons. Armor: water-line belt, 315 feet long, of 10 to 12 inches of steel; turrets 9 inches, conning tower 12 inches, protective deck 2 to 3 inches, ammunition tubes 8 inches. Armament: two 11-inch Hontoria guns, one forward, one aft, singly in turrets; ten 5.5-inch R. F., and twenty-two smaller caliber R. F. and machine guns, with eight torpedo-tubes, two being submerged.

[DENMARK.]

[ENGINEER.]

The Danish ironclad Skjold was recently launched from the Royal Dockyard, Copenhagen, in the presence of the King and Queen of Denmark and a distinguished gathering. The displacement is 2156 tons; she has twin propellers, and the engines are calculated to give 2200 indicated horse-power. The length is 221 feet and breadth 37 feet. The Skjold is built of steel, and has 51 water-tight compartments, besides the compart-

ments in the double bottom. The armor extends from 3½ feet below to 3 feet above the water-line, and consists of 9-inch Harvey steel, decreasing down to 7 inches towards the ends of the ship. The turret armor is 8 inches, and there is a protective armor deck, 2 inches, over the whole of the ship. The armament consists of a 9-inch, about 25-ton, breech-loading gun, in the turret; three 5-inch rapid-firing guns, in three small turrets, each protected by 5-inch armor; four smaller rapid-firing guns and two mitrailleuses. The Skjold will be fitted with electric working appliances for the working of the turrets and for the handling of the ammunition.

[JAPAN.]

THE FUJI.

[THE ENGINEER.]

The Japanese war vessel launched on Tuesday, March 31, from the Thames Ironworks and Shipbuilding Company is named the Fuji, or "Unequalled," and the following are a few of the principal features of her design: Length between perpendiculars, 374 feet; breadth, 73 feet; draught of water, 26 feet 6 inches; displacement, 12,450 tons; coals at this draught, 700 tons; total capacity, 1300 tons.

The original inquiry in 1883, through Admiral Ito, was for an improved Collingwood, but the displacement tonnage was to be limited to 8000 or 8500 tons, and seeing it was difficult to improve on a Collingwood with 1500 tons less weight, the necessity of a larger tonnage soon became evident, and a limit was then given of 10,500 tons, or a Centurion type; but as it was required to carry a heavier armament than that vessel, a still larger tonnage became necessary, resulting in a vessel of 12,450 tons, of the Royal Sovereign type, as above. The Fuji has an armor belt 226 feet long, 18 inches thick through machinery and boiler spaces, and 16 inches at ends; two barbettes, armor-plated with 14-inch armor, and standing upon the armor deck. A screen of 6-inch armor runs across on the main deck, as well as on the lower deck, to protect the broadside 6-inch quick-firing guns from a raking fire; also a belt of 4-inch armor on 2-inch teak backing between main and lower decks of about the same length as the main belt.

The barbettes carry two 12-inch breech-loading guns in each, with armored shields 6 inches thick, also ten 6-inch quick-firing guns, four of which are in casemates and the other six on the upper deck, and protected by heavy shields; twenty 3-pounder Hotchkiss quick-firing guns, four 2½-pounder Hotchkiss quick-firing guns, and five 18-inch torpedo ejectors, one above water and four below.

The armor deck extending from stem to stern is 2½ inches thick, and terminates in a powerful ram at the fore end. The decks are of teak. There are two military masts with double tops, with derricks for lifting the boats in and out from off the skid beams. Thirteen boats in all are to be carried, including two 56-feet vidette boats, navy pattern. Five search-lights, and the whole of the vessel to be lighted internally by electricity. The conning tower is 14 inches thick, and the director tower aft 3 inches thick.

In view of the disastrous effects of the shell fire from the machine guns, as witnessed in the late war with China, all woodwork is substituted by steel and other metal wherever possible. The seamen's mess-shelves, and

also other fittings, as the bulkheads of the saloons and cabins, are all of steel and brass. The engines, which are triple expansion, of 14,000 horse-power, are constructed by Messrs. Humphrys, Tennant & Co., of Deptford, the boilers being of the usual cylindrical type. Speed, 18¾ knots. The vessel has been designed by Mr. George C. Mackrow, naval architect of the Thames Ironworks and Shipbuilding Company.

Good progress is now being made with her construction, as upon the cessation of hostilities with China it was suggested by the Japanese Government that the time of completion should be shortened, and the past few months have made a very material change in her general appearance on the slip, otherwise the delivery was not required for five or six years, so that twelve months' time has been lost. Some 7300 tons of material are in her, including 1600 tons of Harveyed armor, some of which plates weigh 28 tons and cost £2870 each. The armor for the hull has been made by Messrs. Vickers & Son, of Sheffield, and the nickel casemate armor by Messrs. William Beardmore & Co.

The construction of the vessel is under the superintendence of Captain Takayama, that of the engines under Captain Miyabara, that of the armament under Lieutenant Kitakoga, while Captain Yendo, who is also Naval Attaché to the Imperial Japanese Embassy, is the chief of the Commission. The Thames Ironworks find, however, that they are entering upon a new experience in fitting out this large vessel and adapting and fitting all the multitudinous departments to the requirements of their clients in the far East. In Europe, methods of feeding and systems of carrying provision for crew and officers are fairly uniform, barrels and cases being of pretty general proportions, but the Japanese provisions are stowed in barrels, conical shape, something like our harness casks, and most inconvenient for stowing, as the larger diameter is at the top, and not at the bottom, as with us, so that each barrel or cask has to have its allotted place, and consequently there is a great loss in stowage.

[DEUTSCHE HEERESZEITUNG.]

The ship-building programme contemplates the expenditure of 240 million marks, to be extended over a period of several years. According to this programme there will be built four battle-ships, nine protected cruisers (four 1st class, three 2nd class, two 3rd class), three torpedo cruisers, one torpedo transport ship, arranged to carry six torpedo-boats, eleven torpedo-boat destroyers, twenty-three torpedo-boats 1st class, thirty-one 2nd class, and thirty-five 3rd class.

The battle-ships will be of 15,140 tons displacement; the armament to consist of four 11.8-inch guns arranged in pairs in barbette turrets, twelve 5.9-inch R. F. guns, about thirty guns of smaller calibers; also five torpedo-tubes, four of which are under water. Speed to be 17.5 knots.

The cruisers 1st class to be of 7500 tons displacement, with a speed of 21 knots, armed with two 9-inch, ten 5.9-inch R. F., and twelve 2.6-inch guns. The cruisers 2nd class are to be enlarged Yoshimos of 4870 tons, with a speed of 22.5 knots, armed with rapid-fire guns, viz., four 5.9-inch, eight 4.7-inch, and a number of guns of smaller calibers. The 3rd class cruisers of 3200 tons and the torpedo-cruisers of 1200 tons to have a speed of 21 knots; armament of four 4.7-inch and four 2.6-inch R. F. guns. The torpedo-transport, of 6750 tons, to have a speed of 21 knots. The following are the displacements and speeds for the torpedo vessels:

Torpedo-boat destroyers 254 tons, 30 knots; 1st class torpedo-boats 120 tons, 24 knots; 2nd class torpedo-boats 84 tons, 22 knots; 3rd class torpedo-boats 54 tons; torpedo-boats on board the transport 11½ tons. Three battle-ships, two 1st class cruisers, one 2nd class cruiser, the torpedo-cruisers, the transport with its six boats, four destroyers, four 1st class and several of the 2nd class torpedo-boats to be built in Europe, the others to be built in Japan.

[CHILE.]

THE ESMERALDA.

[ENGINEERING.]

The Esmeralda, cruiser, built for the republic of Chile by Sir W. G. Armstrong & Co., Newcastle-on-Tyne, was launched on May 15. The principal dimensions, etc., of the vessel are as follows: Length between perpendiculars, 436 feet; extreme breadth, 53 feet 2 inches; draught (mean), 20 feet 6 inches; displacement, 7000 tons. The vessel is flush-decked, built entirely of steel, sheathed with wood, and coppered. All her machinery, magazines, and steering gear are kept entirely below the curved steel protective deck, which varies in thickness from 1½ inches in wake of the armor belt to 2 inches at the ends. She is also provided with an armor belt 7 feet wide, extending over about 350 feet of her length, and having a thickness of 6 inches. At the ends of the belt there is a 6-inch transverse bulkhead. The coal bunkers are situated above the protective deck, and when filled with coal will add materially to the water-line protection of the ship. Space is provided in the vessel for 1200 tons of coal at the load draught. Her armament is composed entirely of Elswick quick-firers, and is as follows: Two 8-inch with heavy shields, placed one forward and one aft, and each having about 270 degrees of training; sixteen 6-inch, four of which are placed on the bridges forward and aft, and twelve on the upper deck, four of them firing right ahead and four right astern, while eight can train on each broadside. The auxiliary armament consists of eight 12-pounders, ten 6-pounders, and four Maxims, placed in advantageous positions. In addition she carries three torpedo-tubes, one fitted in the stem above water and two submerged on the broadsides. It is estimated that she will have a speed of 22¼ knots with natural draught.

THE ALMIRANTE SIMPSON.

[JOURNAL ROYAL UNITED SERVICE INSTITUTION.]

A new torpedo-gunboat, the Almirante Simpson, was also launched from the yard of Messrs. Laird & Co., at Birkenhead. The vessel is an improvement on the Almirante Lynch, built by the same builders for Chili some years back, and the Onyx, built for the British navy. The dimensions are: Length, 240 feet; beam, 27 feet 6 inches; draught, 10 feet 6 inches, with 800 tons displacement. The armament consists of one bow and two broadside torpedo-tubes for 18-inch torpedoes, two Armstrong 4.7-inch Q. F. guns, and four Maxim-Nordenfeldt 3-pounders. The machinery consists of twin-screw triple-expansion engines of 4500 I. H. P. The boilers are of the Normand water-tube type, with a pressure of 200 lbs. The estimated speed is 21 knots. The range of action at 10 to 11 knots speed is about 4000 knots. The plating of the sides and deck for the length of the machinery space is increased in thickness to afford protection to the engines.

The Teniente Serrano.

On the 16th of May was launched at Birkenhead, from the works of Messrs. Laird Brothers, the new torpedo-boat destroyer Teniente Serrano, the third of the four building by this firm for the Government. These vessels are 210 feet long, with a beam of 21 feet 6 inches; the engines are to develop 6000 I. H. P., giving a speed of 30 knots. This is the seventh 30-knot destroyer launched during the last eight months by Messrs. Laird.

Six first-class torpedo-boats are being built by Messrs. Yarrow & Co.; they are 152 feet 6 inches in length by 15 feet 3 inches beam, and will be propelled by triple-expansion engines, to give a guaranteed speed of 25½ knots. The bunker capacity is 40 tons, which will give a very large range of action. The I. H. P. will be about 2000, and they will be an improvement on the Viper, which vessel was lately built by the firm for the Austrian navy. This vessel, it will be remembered, attained a speed for three hours of 26.6 knots, with a consumption of 1.9 lbs. of Welsh coal per I. H. P. per hour, with an air pressure of ⅞ of an inch in the stokehold.

[Argentine.]

The Varese.

[Militär Wochenblatt.]

The Italian armored cruiser Varese, building at Leghorn, has been purchased by the Argentine government. The dimensions of the Varese are as follows: Length, 328 feet; breadth, 59 feet; draught, 23 feet; displacement, 6840 tons. Complete nickel steel armor belt of 6 inches, above it for ⅔ of ship's length to height of upper deck 6 inches, 6-inch bulkheads protecting base of barbettes. Two 6-inch barbette turrets. Deck above battery 1.9 inches, protective deck .8 to 1.5 inches. There are eight cylindrical boilers, two triple-expansion engines, twin screws. With forced draught and 13,400 H. P., speed of 20 knots. Coal capacity 1000 tons, besides liquid fuel in double bottoms. Armament: Two 10-inch B. L. R's, ten 6-inch, six 4.7-inch, ten 6-pounder, ten 1-pounder R. F. guns, all fitted with gun-shields, besides two machine guns and five torpedo-tubes. The Garibaldi, purchased last year, was renamed the San Martin, and it is probable that the Varese will also be renamed.

Torpedo Boat Destroyers.

[Engineering.]

On Saturday afternoon last, May 16, there was launched from the yard of Messrs. Yarrow & Co., at Poplar, a torpedo-boat destroyer, which differs somewhat from vessels of this class built for the British navy, chiefly in respect of being armored.

The boat in question is one of four similar vessels now in course of construction at Poplar. Her length over all is 190 feet 8 inches, her breadth 19 feet 6 inches, and her depth amidships 12 feet. With a draught of 5 feet the displacement will be about 250 tons. The machinery consists of two sets of triple-expansion engines of the type usually placed in torpedo craft by this firm. The cylinders are 18 inches, 26 inches, and

39½ inches in diameter by 18 inches stroke. There are two condensers, and the usual auxiliary engines for steering, electric light, distilling, air compressors, etc. There are six boilers of the Yarrow water-tube type, capable collectively of supplying steam for 4000 indicated horse-power. The weight of each of these boilers is 6¾ tons with water and fittings. The propellers are of manganese bronze, each with three blades, and are 7 feet in diameter by 8 feet pitch.

The armament comprises one 18-inch torpedo-tube, built into the stem for bow fire, and two 18-inch swivel torpedo-tubes on deck aft. The latter command both sides of the vessel. There will be a 14-pounder quick-firing gun mounted on the conning tower forward, three 6-pounder quick-firing guns on the deck aft, and two Maxim automatic guns just abaft the conning tower, one being on either side.

For feeding the boilers, the new system adopted by this firm has been fitted. There is in the engine-room a main feed pumping engine, which takes water from the hot-well and pumps it into a large cylindrical vessel at a pressure of 30 lbs. to the square inch. Across this vessel are stretched diaphragms of flannel through which all the water going to the boilers has to pass, in order to abstract grease. Leading from this vessel is a single-feed main, which runs the length of the boiler compartments. To each of the six boilers there is a separate feed pump which has its suction from the feed main. The steam pipe to the separate feed pump is taken from its boiler at a point about the normal water-level, there being, however, an interval swivelling pipe by which the level can be altered if necessary. If the boilers become too full, water, in place of steam, flows into the steam pipe. The pump steam cylinder thus becomes choked, and the action of the pump is all but stopped. When the water-level falls again, through evaporation taking place in the boiler, steam once more passes to the pumping engine, which thus recommences its proper functions. The exhaust from the pumps is not taken to the condenser, but into the feed main.

The policy of armoring these small craft has been a good deal discussed lately, the interest in the subject having been revived by some operations during the late war in the East. About 11 years ago Messrs. Yarrow & Co. built for the Japanese Government a small vessel, the Kotaka, which was protected by armor, and was, we believe, the first high-speed armored torpedo craft. It will be remembered that during the late war the Kotaka led two important torpedo attacks, and came through comparatively unharmed, whilst the unarmored boats suffered severely. The price paid by armor is, of course, loss of speed, but the Argentine naval authorities are evidently of opinion that it is advisable to sacrifice something in swiftness in order to gain protection. In our own navy there are, as stated, no armored torpedo craft, it being held that the very thin armor, which alone can be used, is comparatively useless, or worse than useless, whilst it destroys the most valuable quality in these little vessels—their paramount speed. Speed, however, is a relative term. These Argentine destroyers are to steam 26 knots, which would be sufficient to enable them to perform their ostensible duty of putting out of action torpedo-boats proper. It is now generally recognized, however, that "destroyers" are but torpedo-boats of a larger growth, and this is fairly well shown by the fact that the present vessels have each three torpedo discharges, which are certainly not intended for use against small craft. Whatever may be the intention of the designers,

however, one may be sure that no naval officer in command of a destroyer would lose the opportunity of bagging a battle-ship or cruiser. For such an opportunity the chief advantage of speed is that it enables the attacking boat to pass "the zone of fire" very quickly. Armor naturally lessens this advantage, but whilst it detains a boat longer under fire, it would keep out a great many projectiles that might otherwise prove fatal. It is, of course, guns of the smaller natures that torpedo craft have most to fear. The very limited target they present warrants them in taking their chance of a blow from the larger and comparatively slower firing weapons. In any case no protection could be provided against these. The machine gun sends a stream of bullets which may almost be likened to a jet of water from a hose, and, once the range were obtained, would soon play havoc with the ordinary thin plating of the average torpedo-boat. It is to keep out these projectiles that ½-inch armor has been added to the Argentine boats. This armor entirely surrounds the engines and boilers, the bulkheads at the ends of the machinery space being also of steel ½ inch thick. The estimated speed of these boats, 26 knots, may be compared with the 30 knots of the unarmored destroyer Sokol, built by Messrs. Yarrow. The Russian boat, however, though the same length, was a foot narrower, and, moreover, was built of a special steel which enabled the scantling to be lightened.

Messrs. Yarrow have at present a very full yard, the whole of the work being done for foreign governments. There is in course of construction, in addition to the four Argentine destroyers, a large stern-wheel boat for the Russian Government, a twin-screw gunboat for Brazil, and six first-class torpedo-boats for the Chilian navy, besides some smaller craft. At the present time we learn there are about 1100 men employed at the Poplar yard in the construction of these small war vessels.

[BRAZIL.]

BRAZILIAN WARSHIP BUILDING NOTES.

[MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.]

The following war-ships are building: Two battle-ships in France, three torpedo-cruisers and three first-class torpedo-boats in Germany, and two monitors in Brazil.

THE CARAMURA.

The torpedo-cruiser Caramura was launched at Kiel, April 1. The principal dimensions are: Length, 79 ms.; beam, 9.4 ms.; draught, 3.1 ms.; displacement, 1030 tons. Two triple-expansion engines with 6000 I. H. P. to give a speed of 23 knots. Armament: Two 10.5-cm. R. F., six 5.7-cm., and four 3.7-cm. Nordenfeldt R. F. guns; two 45-cm. broadside and one bow torpedo-tubes.

[SAN DOMINGO.]

GUNBOAT RESTAURACION.

Messrs. Napier, Shanks & Bell, Yoker, launched on the 15th inst. the twin-screw gunboat Restauracion, which has been built by them to the order of Messrs. Frame, Alston & Co., London, for the government of

San Domingo. The vessel, which has very fine lines, ram bow, and gunboat stern, is the second constructed by the same builders for the republic; but the new vessel differs from her predecessor, the Independencia, in being larger in size and with greater speed, and otherwise better adapted for war purposes, having barbettes fitted on the sides mounted with Hotchkiss quick-firing guns, similar guns being also mounted at the bow and stern. The Restauracion is 214 feet over all by 30 feet beam. Rooms are provided for the President and his suite, besides accommodation for officers and artillerymen. The machinery is being fitted by Messrs. Dunsmuir & Jackson.

BOOK NOTICES AND BOOKS RECEIVED.

A TEXT-BOOK OF ORDNANCE AND GUNNERY, prepared for the use of Cadets of the U. S. Military Academy. By Captain Lawrence L. Bruff, Ordnance Dept., U. S. Army. Published by John Wiley & Sons.

In the preface to this volume of 675 pages the author states that "the present text-book has been compiled with the object of presenting as clearly as possible the elementary principles of the course in Ordnance and Gunnery as taught at the Military Academy, and of so arranging it that it can be readily used for recitations in the section-room. . . ."

The contents are arranged in chapters as follows: I. Gunpowder and Interior Ballistics; II. High Explosives and Smokeless Powders; III. Guns; IV. Projectiles and Armor; V. Fuzes and Primers; VI. Exterior Ballistics; VII. Artillery Carriages; Theory of Recoil; VIII. Pointing; Probability of Fire; IX. Portable Arms; X. Machine and Rapid-fire Guns. Index. H. G. D.

HAND-BOOK ON NAVAL GUNNERY, by Cyrus S. Radford, Lieut., U. S. Marines; revised and enlarged with the assistance of Stokely Morgan, Lieut., U. S. Navy. Published by D. Van Nostrand Company, New York.

The revised second edition of this excellent manual is well up to date. The book has already proven so useful that a frank criticism of the errors of the present edition can do it no injury.

A serious blunder is made on page 19, where the Fletcher (modified Farcot) breech mechanism for large b. l. guns is correctly described, but illustrated (with lettered references) by a plate of the older and quite different mechanism which it has supplanted.

The new telescope sight is well discussed on pages 38 and 39, but the answer in regard to compensation for drift is a little misleading, for the permanent angle of inclination of trunnions will differ in different guns, as it now does for their sight-bars.

A misnomer occurs on page 54, where an 8-inch turret mount is called a rapid-fire mount.

The statement on page 82 that 53-mm. H. R. C's are to be found on board ship might lead to the belief that there are some 53's in the U. S. Navy, whereas there are none.

It is stated in error on page 120 that brown prismatic powder grains are the same size for all calibers. The forms of smokeless powder grains described on page 123 have been discarded in favor of flat strips.

The catechism on automobile torpedoes should be rewritten, now that the Bureau of Ordnance publications upon those weapons are available.

As evidences of careful attention to progress, there will be found in this edition a description of the Fletcher rapid-fire breech mechanism and of the new electric primers, with illustrations of each.

The hand-book is to be furnished to all ships' libraries, and has been issued to officers and non-commissioned officers of the U. S. Marine Corps and of the Naval Reserve. Considering its wide field among the latter, a chapter upon arming and equipping boats and a good cutlass drill might be profitably added. J. M. E.

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APRIL 10. Assistant Engineers in the Royal Navy. The Causes of Mysterious Fractures in the Steel used by Marine Engineers as revealed by the Microscope (illustrated). Measurement of Feed and Circulating Water, etc., by Chemical Means (illustrated).

APRIL 17. Naval Architecture. A Few Principles Popularly Explained. Engineers in the Royal Naval Reserves.

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JUNE 19. The Institution of Naval Architects in Germany. New Destroyers now Building. The Boilers of Torpedo-boat Destroyers. Recent Improvements in Docks and Docking Appliances (illustrated). Use of Electricity on board Ships.

ENGINEERING.

APRIL 3, 1896. Compound Marine Boilers. Classification of War-ships. Losses in Battle. Royal Armor-clad Sicilia.

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APRIL, 1896. Marine Boiler Explosion. Liquid Fuel and Methods of Burning it. Launch of a Japanese Battle-ship at Elswick. Stokehold Temperature in Ships. The New Third-class Cruiser for H. M. Navy. The Navy Estimates.

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APRIL, 1896. The Concentration of the French Fleet in the English Channel, 1803 to 1805, planned by Napoleon. The Behavior of Torpedo-boats in Heavy Seas. A Test of Dillingen 6-inch Face-hardened Armor Plates. Protection against Collisions. Old Books on Naval Architecture. Foreign Naval Notes.

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MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

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DEUTSCHE HEERESZEITUNG.

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MILITÄR WOCHENBLATT.

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ANNALEN DER HYDROGRAPHIE UND MARITIMEN METEOROLOGIE.

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JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

APRIL, 1896. Gold Medal Prize Essay: "In view of the changes which have taken place in the composition of fleets during the present century, what system of entry, training, and distribution is best calculated to ensure an efficient body of officers and men of all branches for a peace and war establishment?" by Commander J. Honner, R. N. Essay for the Gold Medal Competition (honorably mentioned and recommended to be published by the referees); by Captain S. M. Erdley-Wilmot, R. N. The Tactics of the Future: a Review of Captain F. Hoenig's "Untersuchungen über die Taktik der Zukunft"; by Lieut.-Col. W. A. H., R. E. (continued).

MAY. The Volunteer of To-day: his Military Status, Duties and Training. Naval Essay: The Tactics of the Future. On Electric Ventilators.

JUNE. Photograph of the French First-class Battle-ship Hoche, the New Flagship of the French Channel Squadron. Meteorology: a Factor in Naval Warfare. The Necessity for an Army as well as a Navy for the Maintenance of the Empire. Abyssinia: a Brief Sketch of its Geography and History, with Map. The French 120-mm. Field Howitzer, with Plates. Short Notes on War Balloons.

REVUE DU CERCLE MILITAIRE.

MARCH 14, 1896. "Le Sociable Militaire."

This is the name given by M. Ch. Morel, the well-known manufacturer of the folding bicycle, to his last invention. The Sociable Militaire is composed of two folding bicycles braced together. It is intended, 1st, to permit fighting troops of velocipedists to move in a more compact formation, and thus get rid almost entirely of the long line of cyclers when marching with troops of other arms; 2nd, to render the passage of cyclers on roads slippery from rain or snow secure, by making a fall next to impossible; 3rd, to allow of the wounded cyclers being brought away by their comrades, and thus prevent them from falling into the hands of the enemy; 4th, in a campaign, to allow of missing or disabled cyclers being replaced by men not used to the wheel; 5th, to transport the sacks of cyclers and implements of war (dynamite, powder, tools, etc.) when on a special mission, and do away with the slow and cumbrous transportation by carriages and pack-animals; and, finally, to secure for the companies of cyclers all the independence they need.

APRIL 4. The Dervishes and the Egyptian Soudan (with a map).

It is a picture of the actual situation of affairs on the Upper Nile, which the author proposes to continue later, with a study of the operations of the expedition.

APRIL 11. The Art of Commanding: Reflections and Observations (continued).

LE YACHT.

MARCH 7, 1896.—

A paragraph in a circular recently sent to the Préfets Maritimes informs the latter that torpedo-boats actually in commission must go out to sea for practice at least twice a week.

MARCH 14. Reforms in the Central Administration of the Navy.

A novel idea is the formation of a Civil Bureau (Cabinet) in the Navy Department, parallel with the military cabinet. It would have charge of all civil affairs, the civil personnel of the Central Administration, and will also collect and centralize all matter referring to the preparation of the Navy estimates, as well as serve as an intermediary between the navy and Parliament.

Association Technique Maritime: the Battle of Yalu and its Effects upon Naval Constructions.

MARCH 21. The Composition of War Fleets.

It is an exposé of naval history during the last decade, and shows that M. Desbarres is a shrewd observer.

APRIL 4. Apropos of the Egyptian Question. The Superior School of the Navy. The Projected Naval Budget for 1897.

MAY 30. Petroleum as a Fuel. The Problem of the Fighting Ship.

REVUE MARITIME.

APRIL, 1896. At Madagascar. Nossi-Ve and the Southwest Coast Trade. The Sea-going Torpedo-boat Lansquenet. Influence of Sea Power on History (1660-1783) (continued).

MAY. A Note on the Deviations, Regulation and Compensation of Compasses. A New Telemer giving at once the Height of the Masts. An Essay on the Gyratory Effect of the Screw. Diseases of Sailors and Nautical Epidemics.

LE MONITEUR DE LA FLOTTE.

MARCH 28, 1896. The Necessary Effort.

The writer seems possessed with the idea that an imminent peril threatens France from the other side of the Channel.

APRIL 11. Phonic Signals at Sea.

APRIL 18. The Submarine Boat.

Under that title is given in several numbers the history of the progress made in France in submarine navigation.

J. L.

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*Lieutenant J. H. Glennon, U. S. N., tendered his resignation as Secretary and Treasurer on February 12, 1896. The Board of Control elected Lieut. H. G. Dresel, U. S. N., as Secretary and Treasurer, and elected Commander Edwin White, U. S. N., as a member of the Board of Control.

SPECIAL NOTICE.

NAVAL INSTITUTE PRIZE ESSAY, 1897.

A prize of one hundred dollars, with a gold medal, is offered by the Naval Institute for the best essay presented on any subject pertaining to the naval profession, subject to the following rules:

1. The award for the prize shall be made by the Board of Control, voting by ballot and without knowledge of the names of the competitors.

2. Each competitor to send his essay in a sealed envelope to the Secretary and Treasurer on or before January 1, 1897. The name of the writer shall not be given in this envelope, but instead thereof a motto. Accompanying the essay a separate sealed envelope will be sent to the Secretary and Treasurer, with the motto on the outside and writer's name and motto inside. This envelope is not to be opened until after the decision of the Board.

3. The successful essay to be published in the Proceedings of the Institute; and the essays of other competitors, receiving honorable mention, to be published also, at the discretion of the Board of Control; and no change shall be made in the text of any competitive essay, published in the Proceedings of the Institute, after it leaves the hands of the Board.

4. Any essay not having received honorable mention, may be published also, at the discretion of the Board of Control, but only with the consent of the author.

5. The essay is limited to fifty (50) printed pages of the Proceedings of the Institute.

6. All essays submitted must be either type-written or copied in a clear and legible hand.

7. The successful competitor will be made a Life Member of the Institute.

8. In the event of the Prize being awarded to the winner of a previous year, a gold clasp, suitably engraved, will be given in lieu of a gold medal.

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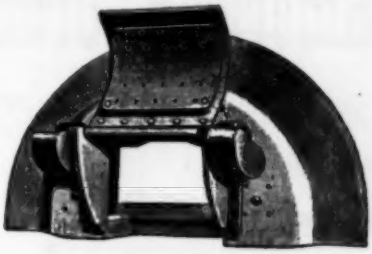

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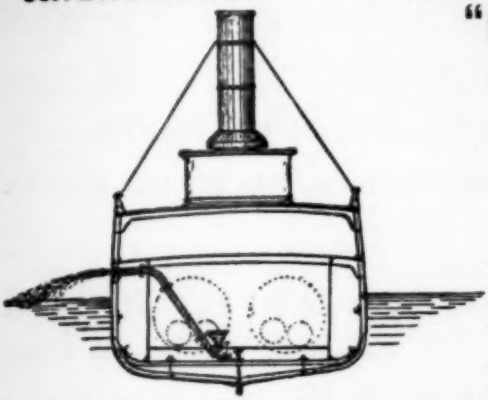

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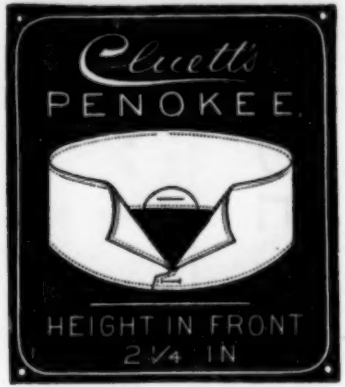

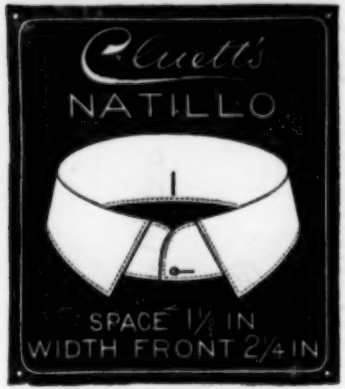

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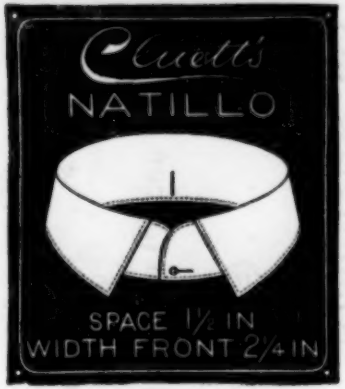

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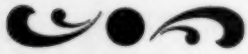

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